ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXV. No. 3.

TABLE OF CONTENTS.

Engineering News of the Week.....49, 57, 58

Technical Articles:

Passenger Elevators of the North Hudson County Ry. *(with inset, illustrated)*..... 50
Wire Ropes *(illustrated)*..... 50
Cable and Locomotive Towage on Canals..... 52
Sugar in Mortar..... 52
The Folsom Dam, American River, Cal..... 52
The Proposed Works of the Pueblo Gravity Water Supply Co. *(illustrated)*..... 53
Proposed New Terminal Arrangements for the Brooklyn Bridge *(illustrated)*..... 54
Japanese Lacquer for the Protection of the Hulls of Ships..... 55
Legal Decisions of Interest to Engineers..... 55
Brick Dust Cement..... 56
The Pintsch Compressed Gas System of Lighting Buoys and Beacons *(illustrated)*..... 56
The Corinth Canal *(illustrated)*..... 56
The New Water-works of Colombo, Ceylon..... 57
Two Devices for Providing Side Motion in Car Trucks *(illustrated)*..... 64
Subaqueous Foundations *(illustrated, continued)*..... 66
The Elmira Steam Generator *(illustrated)*..... 67
Casting a Screw Thread..... 67
The United States-Nicaragua Canal Treaty of 1884..... 68
Paris Street Cleaning..... 68
The Western Traffic Association..... 68
Weather Report for December..... 69

Personals, New Publications, Society Proceedings.....58, 59

Editorial Notes.....60, 61

Mr. Ernst Schoenrock—Engineers for Brazil—Payment of Dues by Voting Members of Am. Soc. C. E.—Ballots for Officers—The Nicaragua Canal—Cost of Transportation on English and American Railways—The Good of Automatic Brakes and Couplers.

Editorial:

The Electric Motor for Passenger Railways..... 61
Concerning an Open Letter..... 62

Correspondence.....63, 64

Cement Tests—Improved Appliances for Cement Testing—Progress on the Busk Tunnel, Colorado—San Diego Sewerage—An Open Letter.

Construction News.....69–72

Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

THE GROSS EARNINGS OF 129 RAILWAYS for the calendar year of 1890, according to statistics collected by *Bradstreet's*, amount to $484,239,134 on a total mileage of 85,678 miles. This is a gain of 8.6% in earnings and 2.7% in mileage. This follows a gain in 1889 over 1888 on 130 roads of 8.5%. For the year every group of roads shows an increase, the smallest gain being that of the Mexican roads, seven-tenths of 1%, and the largest that of the southwestern roads, 12.7%. In addition to the latter three others show gains in excess of 10%, viz., the Eastern roads 10.3%, Southern roads 12%, and Pacific roads 10.9%. The central Western roads gain 9.5% and the grangers 8.6%, while the trunk lines show the comparatively modest gain of 2.4%.

THE BIDS FOR HEAVY GUNS, opened at Washington on Jan. 5, were too high, says the War Department. The bids were for the construction of guns of 8, 10 and 12-in. calibers. The Midvale Steel Co. and the South Boston Iron Works were the only bidders; and both bids exceeded the $3,775,000 authorized by the Fortifications Act of Aug. 16, 1890. The call was for 25 8-in., 50 10-in. and 25 12-in. guns, and the cost of ammunition for tests was to be included. The Midvale Co. bid $22,028 each for the 25 8-in. guns; $51,880 each for the 50 10-in. guns, and $88,592 each for the 25 12-in. guns. The total is $5,359,500, and they were to deliver one gun of each type in 3 years from date of contract, and the whole lot within 8 years. The South Boston Co. bid $20,300 for one 8-in. gun and 350 rounds of ammunition, the gun to be delivered on Jan. 1, 1893. For each of the other 24 8-in. guns they bid $20,995 each, with 10 rounds of ammunition to each. For one 10-in. gun $46,560, including 300 rounds of ammunition, and $48,000 each for the remaining 49 10-in. guns. For one 12-in. gun, and 250 rounds, $76,800, and $80,000 for 250 rounds of ammunition. For the remaining 12-in. guns $79,200 each was bid. The total amount of the bid of the South Boston Co. was $5,027,932.

THE BROOKLYN BRIDGE PLANS, as recommended by the last board of experts, are evidently disappointing to the public, as being woefully inadequate to meet the demands upon the structure, as totally neglecting the convenience and comfort of passengers and as being dangerous. Some of the leading New York dailies have expressed their condemnation freely. Prominent citizens of Brooklyn are quite as much disgusted with the proposed arrangements at their end of the bridge, and figure out that the cost of property alone needed for the proposed change in their city would be $3,500,000. The new terminal facilities may not be so cheap as some foretell.

THE HENNING RAPID TRANSIT CO. has filed articles of association with the Secretary of State, for New York. By these articles the company is to exist 99 years, and is to operate a railroad, commencing in Brooklyn, near Hamilton Ferry, tunnel under the East River and then by further tunnels pass under streets and lands in New York to a point in Westchester County. The length of the proposed road is to be 14 miles, and the capital stock is $150,000, to commence with. The directors are: BENJAMIN S. HENNING, RICHARD MUSER, OTTO ANDRAE, of New York; GRINNELL BUST, of Warwick, and W. E. BOND, of New Canaan, Conn. This is the so-called "toboggan" railway, to be built in a series of undulations, each about one-third of a mile long. It would be in tunnels, the bottom point in each undulation being about 100 ft. below the surface. The inventor figures a speed of 15 miles per hour attained by the descending incline, and this is to carry the trains up the ascending grade to a point where it is grasped by an automatic cable grip and carried to the surface, ready to go down the next incline. A "block signal system is to be used" to prevent accidents. It is expected to make a distance of 8.6 miles in 26 minutes, allowing for 26 stops in that length. Of all the odd schemes proposed in New York for rapid transit this is the most original, and the least likely to pass beyond the incorporation stage.

THE ATLANTIC-PACIFIC RAILWAY TUNNEL CO. is driving a tunnel under Gray's Peak, 60 miles west of Denver, Col. The enterprise has been 10 years in progress and thus far the excavation, which is an 8 × 14 ft. heading has proceeded into the mountain on the east side a distance of 3,000 ft., and on the west side a distance of 1,400 ft. The total length of the tunnel will be 25,200 ft. The enterprise is carried on primarily to tap the mineral veins in the mountain, which are claimed by the projectors to be exceedingly rich in silver, lead and gold. After the tunnel is completed, however, it is intended to enlarge it and open it for railway traffic, and an extension of the Utah Central Ry., built by JOHN W. YOUNG, to form a through line from Denver to Salt Lake City, is projected. It is claimed that this line will furnish a route from Denver to Salt Lake 200 miles shorter than any existing, and will afford a crossing of the main range of the Rocky Mountains 1,000 ft. lower than the Union Pacific or the Denver & Rio Grande. Thus far about a mile of tunnel, including side drifts, has been driven by hand power, but a plant of 10 Rand drills with Ingersoll air compressors has just been put in, and an electric lighting plant is soon to follow.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred Jan. 12 on the Maine Central R. R. near Bemis Station, N. H. The caboose of a freight train broke away near Crawford's, and the train ran down the grade; the engine and first car kept to the track but all the rest of the train went down a high bank. Two men were killed. A collision occurred on the Third Ave. line of the New York elevated railway, Jan. 11, near 118th St. station. A switch engine was coming from the middle track to the southbound track, when it was run into sideways by a southbound train and knocked into the street. The engine driver of the train claimed that the switch was thrown as he approached, and that he could not stop the train at the danger signal. Nobody was seriously hurt.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: On Jan. 12 a wooden bridge carrying the Meriden, Waterbury & Cromwell R. R. over Little River, near Westfield, Conn., gave way under a train, and the engine, tender and baggage car went down. Nobody was hurt. On Jan. 8 a derailed freight train on the Richmond & Danville R. R. wrecked a trestle near Gaffney City, S. C. The engine boiler exploded. Four men were killed and 3 injured. On Jan. 10 an electric car on the Second Ave. Ry., Pittsburg, Pa., was derailed on a trestle at 10th St., and fell over a depth of 15 ft. Several passengers were more or less injured. The railway bridge of the Derby extension between Shilton and Derby, Conn., was carried away by the ice on Jan. 11.

THE BOILER OF A LOCOMOTIVE on the Newport News & Mississippi Valley R. R. exploded at Salt Lick, Ky., on Jan. 8. The engineer was killed. The cap of the dome of a Pennsylvania R. R. passenger engine was blown off Jan. 8, while the engine was standing near the Union Station at Pittsburg, Pa. The tire of an engine on the St. Johnsbury & Lake Champlain R. R. broke recently.

SOME TEN-WHEEL LOCOMOTIVES built for the Wisconsin Central Ry. by the Brooks Locomotive Works, of Dunkirk, N. Y., have the following dimensions: cylinders, 18 × 24 ins.; diameter of driving wheels, 63 ins.; diameter of truck wheels, 30 ins; wagon top boiler, 54 ins. diameter; firebox, 78 × 34½ × 73 ins.; 204 tubes, 2 ins. diameter and 13 ft. 10 ins. long. Grate area, 18.25 sq. ft. Heating surface, 130 sq. ft. in firebox and 1,470 sq. ft. in tubes. Boiler pressure, 180 lbs. Weight on driving wheels, 88,800 lbs.; weight on truck, 29,200 lbs. Driving wheel-base, 16 ft.; rigid wheel-base, 9 ft.; truck wheel-base, 5 ft. 10 ins.; total wheel-base, 26 ft. 1 in. The tender is carried on 33-in. truck wheels, and weighs 75,000 lbs. loaded; it has a capacity of 3,700 galls. of water and 8 tons of coal.

A METHOD OF MEASURING BRIDGE STRAINS is described in *Engineering*, as devised by M. L. LE CHATELIER and described at length in the *Annales des Ponts et Chaussées*. For this purpose a bracket carrying a lathe center is attached by small screws to the member, the strain in which is to be measured. At another point of this bar a second bracket is fixed, in which slides a short steel rod pointed at both ends like a lathe center. Attached to the same bracket is a water chamber closed by a flexible diaphragm of German silver, and connected to a fine open tube, which, as the water, on being expelled from the chamber flows up, serves to measure on a highly magnified scale any motion of the diaphragm. One end of the double-centered rod presses against this diaphragm, and a bar is supported on the other center point of this rod, and on that of the fixed bracket aforementioned. Any extension of the bridge member, therefore, causes a motion of the diaphragm and a fall of the water in the fine tube. Successful measurements have been made on this system when the fixed points between which the extension was taken were only 8 ins. apart.

THE PROPOSED ARLINGTON SUSPENSION BRIDGE, as described in the press of Washington, D. C., would have a river span of 1,100 ft. and two shore spans of 652 ft. each. The clear height at mid-channel would be 105 ft. The two towers would be 210 ft. high, and the extreme width of the bridge would be 54 ft.

THE PROPOSED TUNNEL UNDER NEW YORK BAY, between Staten Island and Long Island, was advocated and explained, on Jan. 12, befor the U. S. Senate Committee on Commerce. Mr. ERASTUS WIMAN dwelt upon the commercial features, and Mr. A. P. BOLLER, C. E., explained the proposed route and plans of construction. It is expected that a bill will be favorably reported on this enterprise.

THE BROOKLYN BRIDGE during the month of December transported 3,466,478 passengers, and 182,385 persons passed over the promenade. The average of daily traffic on both trains and promenade was 117,705 persons, as against 122,346 per day in November. Of the railroad passengers 1,600,000 paid cash fares, and 1,866,000 tickets were sold in bunches. The receipts were $101,452.43, and the expenditures $60,912.62, leaving a balance on hand Jan. 1 o $287,292.85.

THE NOTE ON THE NEWPORT AND CINCINNATI BRIDGE, in our issue of Dec. 27, unintentionally omitted to state that the plans and specifications were prepared by Mr. G. BOUSCAREN, the consulting engineer for the structure.

Passenger Elevators of the North Hudson County Ry.

(WITH INSERT).

The North Hudson County Ry., at Hoboken, N. J., operating both surface and elevated lines in that city, has begun a series of improvements that will greatly increase the ease with which residents along the Jersey Palisades may reach the West Shore R. R. ferry to New York.

The work now under construction comprises a steel viaduct about 875 ft. long, beginning 150 ft. from the ferry at Hoboken and running to the top of the Palisades. It is carried on 7 bents, is 150 ft. above the high water level at the Palisades and 153 ft. at the elevators, and consists of 6 pin-connected and 1 plate girder span. The structure is designed to support a 45-ton mogul locomotive, followed by a train load of 2,000 lbs. per ft. on each of the 2 tracks which it carries. There will be three elevators at the ferry terminus of the viaduct for the purpose of transferring passengers between the elevated structure and the ground. Each will be designed to lift 130 persons 145 ft. at each trip. Passengers can walk to the cliff from the upper landing on footwalks provided for the purpose on each side of the tracks, or else can take the railway for more distant points.

The elevators, which are probably the largest in the world, are being built in the works of Otis Bros. & Co., at Yonkers, and will resemble those supplied to the Eiffel Tower by the same firm. To the kindness of the company and Mr. THOS. E. BROWN, JR., their chief engineer, we are indebted for the following description and cuts:

The three elevator cars will run in the first, or shore, bent of the trestle, as shown on the inset sheet. They will be 21.5 × 12.5 × 10 ft. in size, and operated by the pressure of water stored in a compression tank at the top of the tower. The car frames will be built up of 8-in., 50-lb. wrought-iron channels, and 4 × 3-in. angles, subject to a maximum strain of 9,000 lbs.

The water cylinders will be of cast-iron, 35 ft. long 38 ins. in internal diameter, 2 ins. thick and with top and bottom flanges 50 ins. in diameter and 3 ins. thick. The cylinders will be bored in upright boring mills, which are a special feature of the Otis Bros.' shops. Similar mills have been used for some time on other large cylinders and enable a much greater precision to be obtained than is possible in a horizontal boring machine. The segments will be fastened together by 24 wrought-iron 1¼-in. bolts and the joints packed with heavy asbestos paper.

The base plates are extra heavy castings held to the foundation girders by two 4-in. anchor bolts. The head plates are also unusually heavy and provided with cross ribs through which the pistons work in brass-lined stuffing-boxes. All these castings are made in the foundry belonging to the company. Although this was but recently entirely rebuilt, its facilities are now barely adequate to meet the demands made upon it.

Each lift is calculated to raise 20,000 lbs. at the rate of 200 ft. a minute under a pressure of 175 lbs. per sq. in. The cylinders are tested under a pressure of 500 lbs. per sq. in.

The piston is made of cast-iron, with top and bottom plates in the form of segments of a sphere. This construction is at once remarkably light and strong. The packing is hemp.

Attached to the piston are the aprons (see Fig. 6 on inset sheet) which act as automatic stops by gradually closing the cylinder ports in precisely the same manner that cushioning is produced in steam cylinders. The holes through which the water escapes are spaced most closely at the end which first crosses the ports, in order that the piston may come to a gradual stop. These aprons have been put on a large number of Otis elevators and have given excellent satisfaction in every case. By using them it is possible to run an elevator at the highest speed from the bottom to the top of a shaft and have the car brought automatically to a stop without shock.

The piston is attached to the traveling sheave frame by two 4⅛ in. piston rods of Bessemer or open-hearth steel. The pair of rods are connected to the wrought-iron traveling frame by equalizing forgings, as shown in Fig. 4, and have an ultimate strength of 400 tons. If one breaks, the other has sufficient strength to lift the car without buckling.

There are 8 crucible-steel cables to each car, each formed of 6 strands of 19 wires, twisted about a hemp center, and having an ultimate strength of 42,000 lbs. Six of the cables are attached to the hoisting machinery, the others to counterweights.

The safety appliances are so many in number that the probability of an accident is reduced to a minimum. Each car has two governors of the usual revolving type, so that if one fails the other will act. In addition to an automatic triple-grip stop, the six hoisting cables are attached to an equalizing lever on the upper frame of the car in such a manner that any serious failure of one of them will force a set of safety grips into three sides of the hard wood guides in which the cars run. These devices are remarkably simple in their action, although difficult to describe without cuts. At present the company is not prepared to have them illustrated.

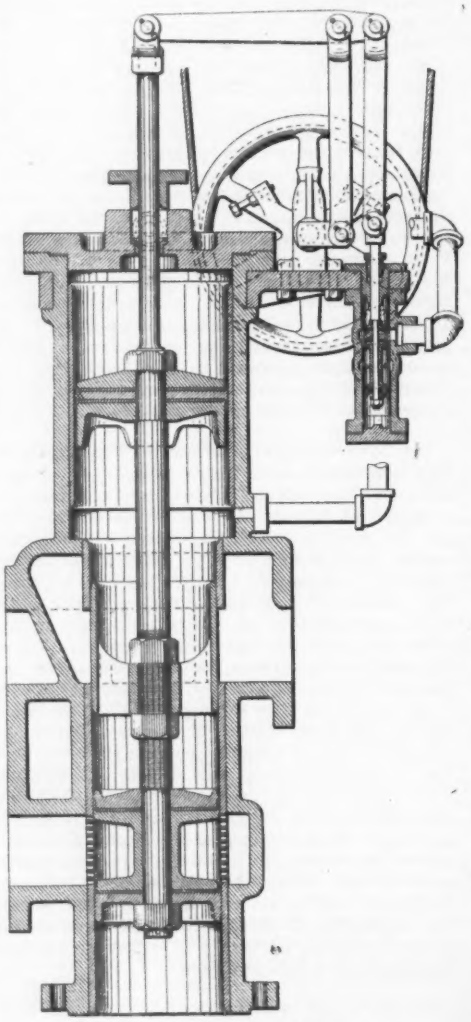


Fig. 7. Operating Valves.

The motion is controlled by a differential piston valve operated by an auxiliary pilot valve. Since the main valve is 9 ins. in diameter it would be impossible to move it in the usual manner, and the arrangement shown in diagram in Fig. 6 has been adopted. Above the main valve and connected with it by a piston rod, is a large auxiliary valve or head, 11 ins. in diameter. Two pipes lead from above and below this 11-in. valve to the small pilot valve at the right. The valve rope from the operating lever on the car passes around a wheel (see Fig. 6), with sufficient tightness to move it when the rope is pulled in either direction. Suppose it is desired to raise the valves, the right hand rope is pulled up, turning the wheel in a direction contrary to the hands of a watch. Since the friction of the large valve is much greater than that of the pilot valve, the latter will be raised by the levers and rods connecting the different parts. This pilot valve will then admit water to the space between the 9 and 11-in. heads, when the excess of pressure against the latter will lift the operating valve and thus admit water to the main lifting cylinder.

In this way it will be noticed that the motion of the pilot and operating valves are always in the same direction. The operating valve is moved downward by admitting water in the same manner to the top of the 11-in. head by a pipe not shown in the diagram. These valves are shown on a larger scale in Fig. 7, which represents the actual shape of the parts.

The pressure tank at the top of the tower contains 10,000 galls., the discharge tank at the bottom 10,000 galls., and an auxiliary tank for storing water has 1,200 galls. capacity. Two Worthington compound condensing pumps will be used. They have 16 and 29-in. steam and 12-in. water cylinders with 18-in. stroke. An air pump will be employed to maintain a proper pressure in the compression tanks, which will be connected with the cylinders by a 15-in. cast-iron stand-pipe.

The viaduct will be built by the Passaic Iron Mills after plans prepared by Mr. E. A. TRAPP, the Chief Engineer of the North Hudson County Ry., who has general oversight of the work.

Wire Ropes.*

The experiments described in this paper were undertaken with the object of discovering some practical means of selecting the best form of wire rope to be employed in the erection of the Forth Bridge. Upwards of 60 miles of wire ropes were employed in connection with that undertaking.

The principal causes which lead to the destruction of wire ropes are: The wearing away of the outer surface of the outside wires, the rubbing of the wires against one another, and fatigue of the steel brought about when the rope is worked over a pulley relatively too small. A good example of ropes which give out by the wearing away of the outside wires is found in tramway cables, while deterioration of the last kind is seen in ropes working on crane barrels or in pulley blocks. In the case of tramway cables no practical consideration calls for small pulleys to guide the rope round street corners or similar leads. It is true that the carrying pulleys must be comparatively small; but these affect the life of the cable very little. Recognizing that the wear of the wires, due to the friction of the car-grips, is in most instances very serious, while the stress due to bending the ropes round the pulleys is comparatively small, it is at once apparent that in this case a stiff rope may be used, having wires of a moderately large diameter, so as to allow of a sensible reduction in size, before the outer wires are worn completely away. On the other hand, it will be observed that the conditions under which ropes work over small pulley blocks are the reverse of those in the case of tramway cables. Small pulleys are, for convenience, a practical necessity, and in consequence the wires must be of a small diameter, so that the stress due to bending round the pulleys may be kept within moderate limits. Flexible ropes are in these instances a matter of absolute necessity, and the tabulated experiments in this paper refer almost wholly to this class of wire ropes.

TESTING MACHINE.

The form of apparatus adopted in the tests was of the simplest kind, and was designed to wear out the ropes in a manner similar to that which takes place in practice. On the testing machine were two pulleys, over which the wire rope was stretched. The lower pulley was attached to a hinged lever *A B*, Fig. 1. This lever was loaded with a movable weight *W* to give the requisite tension. As the rope band was not long enough to allow of satisfactory splicing, and thus continuous running over the pulleys, it was made in two equal sections, joined together by eyes and shackles; a reciprocating motion was thus given to the rope thus strained, by an automatic arrangement (not shown) connected with the upper pulley. A record was kept of the number of bends sustained by each rope put under test, thus affording means for comparison.

GENERAL CHARACTERISTICS.

In table I. are detailed some of the general characteristics of different makes of wire rope. In all cases the ropes were of flexible make, with the exception of those 3 ins. and 4 ins. in circumference. This stiffer type of rope was never called on to perform any other work than the carrying of dead loads, or acting as wind ties. It was ultimately discarded for the flexible ropes, which were as cheap, when allowance was made for the extra strength of the crucible steel and increased handiness.

A cross section of the ropes presents a series of 6 circles clustered around a central one. Each of the 6 outer circles is in contact with the inner one and those on each side. The inner circle, or core, is generally wholly made of hemp, although in some instances several wires are placed in the heart of it, for the primary purpose of pre-

* Condensed from a paper by ANDREW STEVENSON BIGGART, read before the Institution of Civil Engineers.

venting the rope from twisting. The outer circle represents the strands, which are wound round the core, from left to right, at a single angle. The strands, in some cases, have a hemp core, in others a wire one; but of whatever substance the core is, the wires of the strand are laid over it, sometimes from right to left, at other times from left to right.

It will be observed that the ideas of rope manufacturers as to the proper tensile strength of wire vary very much, ranging from 63 tons to 103 tons per sq. in. in the same class of flexible rope.

A point of consideraple importance is the difference between the aggregate strength of a number of steel wires, when tested singly, and that of the same wires when tested in the form of a rope. The loss of strength in the rope (although this cannot be stated with certainty, as the manufacture is in some cases more perfect than in others) seems to be about 10%. The ropes tested were in short lengths, and as they were bent round a solid eye and spliced at each end, it is probable that in ropes of the length usually employed this difference would be considerably reduced.

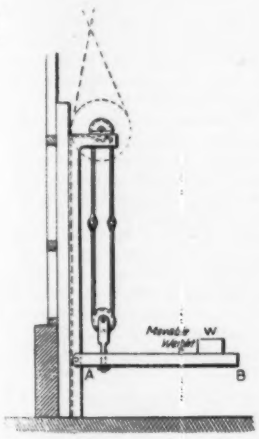


Fig. 1. Machine for Testing Durability of Wire Rope.

If the breaking strength in direct tension of these steel wire ropes is compared with that of hemp ropes and chains it will be found that to obtain equal strength the weight of the hemp rope must be about three times and that of the chain five times the weight of the wire rope.

In a second table the author gives the results of tests of the wire in special 1¾-in. ropes sent by T. & W. Smith for testing purposes. The lowest tensile strength was shown by iron wire, 45 tons per sq. in., and the highest by piano wire, 163 tons per sq. in. These were the average of six tests.

TABLE I.—TESTS OF STRENGTH OF CRUCIBLE STEEL, 6-STRAND ROPES, 1¾ INS. IN CIRCUMFERENCE.

Maker.	Total No. wires.	Diameter of wires. Inch.	B. W. G.	Breaking weight of rope, average of two.† Tons.	Breaking weight of wires, average of six. Lbs.	Breaking weight of wires per sq. in. Tons.	No. of wires multiplied by their average breaking weight. Tons.	Loss per cent.	Ductile test.*	Remarks.
T. & W. Smith.....	72	0.036	20	6.80	212	94.64	6.82	0.3	73	Ordinary flexible.
"	144	0.036	20	10.47	190	84.82	12.22	14.3	78	Special "
"	72	0.036	20	6.62	230	102.68	7.39	10.3	92	Ungalvanized.
Bullivant & Co.....	72	0.040	19	5.85	200	68.68	6 43	9.0	66	Oiled in manufacture.
Dixon, Corbett & Newall.....	....	0.040	19	9.85	228	78.29	.. .	....	46	Lang's patent lay.
R. S. Newall.....	114	0.036	20	5.75	210	93.75	....	....	83	Ungalvanized.

*No. of twists a piece of wire 8 ins long will stand before breaking.
†Strength of larger sizes of rope (T. & W. Smith's make), 2¼ ins. circumference, 14.85 tons; 2¾ ins., 21.90 tons; 3 ins. (Bessemer steel), 14.10 tons; 4 ins. (Bessemer), 26.10 tons.

WIRE.

The wire used in these flexible ropes was understood to be made from crucible steel. The tests adopted for determining the quality of wire were those of tension and torsion. The average tensile strength of the wire used, ascertained by direct pull on the individual wires, was from 80 tons to 90 tons per sq. in.

The torsion, or ductile test, is the number of complete revolutions or twists which wire of a given length will stand before fracture. A piece of good wire, of 20 B. W. G., and 8 ins. in length, should stand from 70 to 80 such turns. The mode of ascertaining this value is to place a piece of wire in an apparatus capable of gripping and rotating one end, while the other is held fixed to a point 8 ins. distant, so that this length of 8 ins. is the only free part of the wire where twisting can take place.

In a second table the author gives results of tests on crucible steel wires No. 20 B. W. G., annealed and unannealed, and galvanized and ungalvanized. The results showed that galvanizing decreased the strength of unannealed wire about 5% and its ductility about 15%. The strength of annealed wire was hardly affected by galvanizing, but its ductility was so reduced that instead of 179 twists it could stand but 58 twists. Annealing the ungalvanized wire reduced its strength 45%, but increased its ductility 77%.

The variation in tensile strength of contiguous pieces of steel wire, both galvanized and ungalvanized, is very little. In the case of galvanized the variation is only 2% while in the ungalvanized wire it is about 8%, in both cases not more than what may be looked for in any ordinary piece of steel.

The results of another series of tests of ductility were more striking. Contiguous pieces of six different series, representing three makes of ropes were tested. In the first series of six wires, all galvanized, the average was 68 twists, while the lowest was 31 and the highest 96. In the second series the number of twists withstood by pieces taken within a few inches of each other, from the same wire, varied in one case from 23 to 58. The average of this series was 62, the lowest being 23 and the highest 90. The last set of six wires, in this table showed an average of 92 turns, while the lowest gave 75 and the highest 103. In this case the wires were ungalvanized, which accounted for the greater ductility of the steel. Another point brought out in these tests is, that the results are practically uniform, whether the wire is, prior to twisting, put under a slight initial tension or left quite free. No appreciable difference is observed in the average result, whether the wires are twisted slowly, or so quickly as to become heated.

Experiments were made to determine the modulus, and limit of elasticity, and the extension under direct pull The results were ascertained on lengths of 100 ins. The modulus of elasticity varied from 22,400,000, in the case of Bessemer iron wire to 35,000,000 in piano steel wire. The ordinary crucible steel wire, showed a modulus of 33,000,000, the permanent set commencing at about half the ultimate tenacity. Permanent set took place in the case of Bessemer iron wire at about 12 tons per sq. in., or about one-quarter of the ultimate tenacity. No guide is furnished as to the point beyond which a permanent set takes place, by ascertaining the ultimate breaking strength of a wire. Permanent set may take place at from 25% to 80%, and even more, of the breaking strength. In galvanized and ungalvanized wire, the ratio of extension up to the elastic limit is practically the same. The extension at the breaking point of good crucible steel wire, may be taken at about 3% in lengths of 100 ins.

PULLEY TESTS.

Reference has already been made to the series of experiments in which ropes were run over pulleys until destruction ensued. The pulleys ranged from 5¼ to 24 ins. in diameter, and flexible steel wire-ropes of 1¾ in. circumference were employed. The results of the tests are given in Table V.

The failure of the ropes was in all cases occasioned by the individual wires gradually giving way, one by one. In no case were the outside wires of the ropes severely worn away, although in a few instances, where the pulleys were large and the number of bends endured before breakage consequently greater, wearing away took place to a considerable extent. Before attempting to describe these experiments in detail, it will be well to examine, briefly, the conditions prevailing in the rope while passing over the pulleys.

To bend a 1¾-in. rope, composed of 72 wires, 20 B. W. G., over a small pulley, where the wires are free to move, is an easy matter. It will, nevertheless, take more than 72 times the power required to bend one of the wires to the same curve. If the wires composing the rope are soldered together at any point near to where the bend takes place, the power required to make the bend will be sensibly increased. The resistance may be thus augmented till it approaches that of a solid bar, as when the wires are all securely joined to one another along their entire length. The movement of the strands, as a rope is bent, is easily observed by the naked eye. If a rope be conceived straight, and under a longitudinal stress, it is apparent that the strands and wires will be held to one another by friction, due to the twisting around each other received during manufacture. The value of this friction may be illustrated by considering the strength of a splice. A splice of 40 ft. in length has the full strength of a wire rope of 80 tons tensile strength. A splice may thus give a resisting power of two tons per lineal foot.

If a rope, under tension, is bent round a pulley, the resistance will be that due to the bending of the individual wires, as beams, plus that due to the increased stiffness given to the wires, as a whole, on account of their being laid into one another.

The resistance to bending, on the part of the individual wires, is highest where small pulleys are employed, and bending in these cases is often the direct cause of by far the greatest separate longitudinal stress in the wires themselves.

If a wire is bent to a radius R, the bending moment at any point is, $M = \frac{EI}{R}$, where I is the moment of inertia of the section of the wire, and E is the modulus of elasticity. The stress consequently due to bending is $f = \frac{EI}{2R}$.

In the following table the stress due to bending a 20 B. W. G. wire, with E equal to 32,000,000, around pulleys of various sizes is given:

Diam. of pulley; ins.	10½	13¼	16¾	18¾	24
Stress due to bending; tons per sq. in	50	40	31.4	28.2	22

It will be observed that the stress, due to bending alone, in a wire 20 B. W. G. diameter, when bent round a pulley 10½ ins. diameter, is 50 tons. This at once shows that the usual ropemakers' allowance, in determining the diameter of the pulley as six circumferences of the rope irrespective of the diameter of the wire, is beyond the limits of prudence, and if acted on will assuredly give a short life to a hard-wrought rope. It is evident that the diameter of the pulley should not be made to depend simply upon the circumference of the rope, but that the size of the component wires should also be taken into consideration.

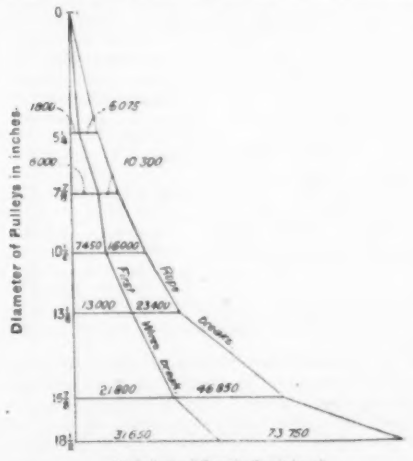


Fig. 2. Diagram showing Durability of Wire Rope run over Pulleys of Various Diameters.

Where small pulleys are employed, the principal stress in a rope, and the one to be kept most in view, is not that due to the uniform direct tension caused by the working load, but is the bending stress just referred to. Other stresses than those named are present in a rope, such as the stress due to centrifugal force, that due to the bending of the wires while being laid on the strands, and also when the strands are being formed into the rope. These last stresses may be discarded, as they happen only once in the life of a rope. If, however, they were recurrent each time the rope passed over the pulley, they would be destructive ones, as they amount to that which produces a permanent set in the individual wires.

The diagram given in Fig. 2 shows, graphically, the increase in the life of the rope as the diameter of the pulleys is increased. No idea is furnished as to the point where the working stresses change from beyond to within the elastic limit, owing to the regularity of the increase. This may be partly accounted for by the fact that the wires, when running over comparatively small pulleys, get much cut up where they cross one another, owing to the longitudinal movement in the rope already referred to. This cutting action is easily observed in the wires, by examin-

TABLE V.—THE LIFE OF FLEXIBLE STEEL WIRE ROPES WHEN RUNNING OVER IRON PULLEYS

The figures in the table give the number of times the rope passed over the various pulleys before breaking. All ropes 1¾ ins. in circumference. Load on rope, 14 cwt. See Fig. 1.

MAKER.	Diameter of pulleys in inches. 5¼.	7⅞.	10½.	13¼.	16¾.	18¾.	24.
Messrs. T. & W. Smith's ordinary rope.....	6,975	10,300	16,000	23,400	46,800	72,700	74,100
Messrs. Bullivant & Co.'s.....	.....	.....	34,800	.....	.....	100,200	336,600
Lang's patent lay.....	.....	.....	53,100	85,200	.....	394,500	.....
Messrs. T. & W. Smith's ordinary rope, oiled.....	.....	.....	38,700	37,300	.....	103,200	286,100
Lang's patent lay, oiled	.....	.....	107,600	142,700	.....	.... .	.....

ing a rope that has run for some time. The effects can be gauged, to a certain extent, by the torsion test; thus, a 1¼-in. rope was run over a 10½-in. pulley 16,000 times, with a load equal to ⅓ of its breaking weight, when it was found the torsion test gave the following average results:

Ductility of wires before running commenced	.....	64
" " near fracture	.....	6
" " at center of wires not broken	.....	3
" " midway between fracture and splice.		30

No doubt much of the deterioration, in the rope referred to, was due to fatigue of the steel, but a large share must also be ascribed to the cutting action of the wires against one another. It is worthy of note that after having been run over the pulleys, the value of the part of the rope nearest the middle, where that cutting movement was greatest, was as 3 is to 30, compared with another part, where the bending was the same but the movement of the wires against each other less. This experiment may be compared with another, where 15,000 bends were given to wires of the same quality as those used in making the rope in the previous experiment. The pulley was of the same diameter, and the torsion endurance of the steel was reduced from 77 to 32. The difference between 3, in the test above referred to, in which the rope stood 16,000 bends, and 32 in this one with the wire, is the loss due to the cutting action of the wires.

This cutting action may be modified to a very great extent by a judicious system of oiling. The oil should be capable of permeating the rope. As is to be expected, the advantages due to oiling are more clearly marked when the ropes are worked within the elastic limit of the steel. For example (see Table V.), Smith's ordinary rope gave on the 10½-in. pulley, when unoiled, 16,000 bends before breaking, but when oiled, 38,700. This same make of rope when running over the 24-in. pulley stood when unoiled 74,000 bends against 386,000 when oiled. In this instance the movement of the wires would be less than in the case of the tests with the 10½-in. pulley. In these tests the wires composing the strands were laid from left to right, and the strands themselves from right to left. The wires, as a consequence, cross one another rather severely.

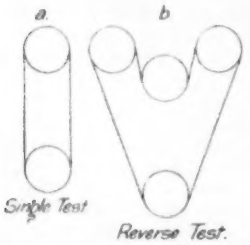


Fig. 3. Tests of Wire Rope, with single bending and reverse.

In Table V. are also the results of some experiments with a type of rope known as "Lang's lay," in which both the wires and the strands are laid from left to right. The result is that the wires composing a strand lie into the wires of the adjoining strands, against which they bear, thus, in a great measure, securing a longitudinal bearing surface throughout. A better bearing surface is also given the outside of the rope, and the cutting action is reduced to a minimum. This rope gave, on the 10½-in. pulley, when unoiled, 53,000 revolutions, against 107,600 when oiled, and 38,700 for the first type of rope, when oiled also.

In connection with the bending of ropes over pulleys, experiments were also conducted to ascertain the difference between running over single pulleys, where the bending is all in one direction (as in Fig. 3 *a*), and over pulleys placed as in Fig. 3 *b*, so that the rope, while running, was subjected to reverse stresses. The results are given in Table VI., and are instructive, as showing that generally the life of a rope, when bent in one direction only, is twice as long as when working under reverse stresses.

Other interesting points are brought out. For example, the life of the first rope tested was longer than that of the second, although the quality of the steel was the same. In the latter the wires cross one another abruptly, while in the former the bearing is almost longitudinal.

Other experiments were undertaken for the purpose of comparing the life of single wires with that of ropes composed of similar wires. The general result was that the life of the wire, when running alone over a pulley was much greater than when in a rope and running over the same pulley. Perhaps the most striking fact in these experiments was the failure of the wires in several cases when the working stress was well within the elastic limit. In all cases this failure was due to the fatigue of the steel, no appreciable wear being observable on the surface of the wires.

From the information gained by the foregoing experiments, some conclusions may be deduced as to the best type of rope to use under varying circumstances. Thus a 1¼-in. flexible rope to run over, say, ordinary pulley blocks, should be made of ungalvanized steel wire, of about 20 B. W. G., with a tensile strength of about 80 tons per sq. in. Hemp cores, oiled during manufacture, should be placed in the strands, as well as in the centre of the rope. The wires and strands ought to be laid in the same direction. Further, when in use, the rope should be regularly oiled, to nullify as much as possible the cutting action of the wires, and at the same time prevent rusting. In a case such as that named the diameter of the pulleys will, owing to practical considerations, always be small, so that what is wanted is the best compromise. The user will be content to pay for a greater number of ropes rather than have the pulleys made of such a diameter as theory and practice point out to be necessary for a long life; and in so doing he will be the gainer, as in almost all cases increased economy is obtained through the use of comparatively small pulleys.

Theoretical considerations would point to a 6 ft. 6 in. pulley as a minimum for a 1¼-in. rope made of 20 B. W. G. wire. Allowance is here made for the effect of reverse stresses, which are always present in the case under consideration. While a general conclusion may be arrived at such as that given, for a wire rope working over pulley blocks under certain conditions, it must be clearly seen that before determining what is the best form of rope for any given work, the conditions of economy under which it is to be used require to be clearly understood and provided for.

TABLE VI.—LIFE OF ROPES WHEN RUNNING OVER 24-IN DIAMETER PULLEYS.
Load on rope in all cases, 14 cwt.

DESCRIPTION OF ROPE. (All T. & W. Smith's make).	Size of wire B. W. G.	Total number of bends before the rope breaks when: Running over one 24-in. pulley. (*Fig. 3, a*).	Running over three pulleys. (*Fig. 3, b*).
Ordinary crucible steel, wire and strands laid in opposite directions	20	74,100	51,000
Wire and strands laid in the same direction	20	..	126,000
Patent improved steel, wire and strands laid in opposite directions	20	90,000	57,000
Plough steel, wire and strands laid in opposite directions	20	109,000	54,000
Iron wire, wire and strands laid in opposite directions	19	66,000	32,000
Crucible steel, wire and strands laid in opposite directions	18	87,000	47,400
Crucible steel, wire and strands laid in opposite directions	22	111,000	48,700

Cable and Locomotive Towage on Canals.

At a recent meeting of the Railway Union in Berlin, Herr WIEBE described some recent and novel experiments on mechanical methods of towing made on the Oder and Spree Canal, now under construction. He stated that the small boats will be handled by horses or men in the usual Continental manner, but large boats will be necessary and some suitable means of propelling them had to be devised.

The use of a fixed chain taken in at the bow and paid out at the stern of the boat is not, according to Herr WIEBE, as good a plan as many claim it to be. Long tows handled by tugs are impossible on this canal on account of the small size of the locks. Hence it became necessary to use some motive power supplied outside of the boats themselves.

Two experimental divisions of the Oder and Spree Canal, some 3.48 miles in all, have been operated since the beginning of last summer by means of endless ropes to which painters from the boats are attached. The rope is driven by stationary engines and carried on pulleys attached to posts. These supports were constructed in all possible forms in order to determine the best construction. The driving rope operated successfully, as a general thing, and it was found an easy matter to cast off or take hold of the painters to which the boats were made fast. The connection between the driving rope and the painters offered numerous difficulties. The rope, while in motion, rotates about its axis and the painters are thus apt to be twisted in spite of all appliances to the contrary. This defect has proved so serious that rope driving is stated to be unsatisfactory.

The other method which has been tried consisted in dragging a tow by means of a locomotive running along the bank of the canal. The French have been accustomed to attach the tow rope directly to the locomotive, but the tension tends to pull the latter sidewise.

In the German experiments a contractor's locomotive is employed, running on a light track similar to that used in mines, and pulling behind it a heavy towing cart, to the center of gravity of which the tow rope is attached. The locomotive passes under all bridges over the canal, and need not be very powerful or run at any but low speeds.

Both rails were found to wear equally, although there is no superelevation on curves. The experiments have so far proved quite satisfactory. A speed of 10 to 12 ft. a second has been sometimes tried, but about 5 ft. per second is sufficient for the purpose. The initial tension on the tow rope on starting 3 heavy coal barges was 1,764 lbs., but after the start the locomotive had a much less duty. On tangents the pull was constant in amount, as might be expected. On convex banks more, and on concave less power was necessary. A rise or fall in grade influenced only the speed not the pull of the locomotive.

Sugar in Mortar.

Some time ago the statement that the mixture of a small quantity of sugar with mortar greatly improved the latter greatly excited the risibles of the building fraternity. The notion was regarded as too ridiculous for serious consideration. There is, however, reason to believe that the addition of saccharine matter to mortar is an extremely valuable discovery. In the first place, it enables bricklaying to be carried on in frosty weather. About 2 lbs. of coarse brown sugar to 1 bushel of lime and 2 bushels of good sand will supply the proportions for a mortar that will resist frost admirably. It is claimed, however, that in addition to this advantage, mortar with sugar mixed in it is vastly superior to mortar without it. It sets as hard as cement very soon, makes the brickwork exceedingly strong, and is quite effective when used with dry bricks. For indoor plastering also saccharated mortar sets hard quickly. Where portions of the same wall have been covered in one part with sugared and in another with unsugared mortar, the latter has ripped up directly when a nail was run over it, months after the former had become as hard as stone. Much interest is taken in this matter by Mr. CRAMPTON, of Cranleigh, Guildford, and he reports some interesting experiments. He points out that if sugar be added to mortar that is already made, it will render it too thin. Strong sugared water dissolves lime in the same way that water dissolves sugar. It is, therefore, necessary to dissolve the sugar in water first, and then add the sugared water to the lime slowly and cautiously. The mortar should be as stiff as it can be used. For lime washing, 1 lb. of sugar to 16 galls. of water will make it adhere splendidly. Drops of white-wash made with water so mixed, if they fall on the floor or window, or on an iron plate, cannot be washed off. Evidently sugar is not such an absurd thing to mix with lime as the practical man thought.—*Manufacturer and Builder.*

The Folsom Dam, American River, Cal.

This dam, the completion of which was noted last December, is a solid granite structure laid in Portland cement. It was built by the State of California under the control of the Prison Commissioners, and all the work was performed by convict labor from the Folsom prison. The dam has been in progress for several years, and its object is the utilization of the water power of the American River for manufacturing purposes at the prison.

The dam is 92 ft. high at the maximum point, about 65 ft. thick at the base and 20 ft. thick at the top. It is provided with a movable shutter, or weir, on top, 6 ft. high. This shutter is to be raised by powerful hydraulic jacks operated by the water power.

The stone was conveyed from a quarry on the left bank to position in the dam by means of a double wire rope spanning the cañon, and about 75 ft. above the top of dam. The length of the span was about 700 ft. and the ropes were 1⅛ ins. in diameter, placed 18 ins. apart and kept taut and exactly level. On these ropes ran a trolley having four 18-in. sheaves in a frame, from the lower end of which were suspended three more sheaves of the same size. The hoisting rope, of ⅝ in. diameter, passed over the three lower sheaves to a double sheave below. Stones weighing 10 tons were hoisted and conveyed with ease and rapidity on this apparatus. The motive power was a powerful double-drum hoisting engine, located at one end under the cable.

The masonry is a fine quality of range rubble work, with the facing stones roughly dressed. M. HUMBERT was the engineer of the work. We are indebted for these details to Mr. J. D. SCHUYLER, C. E., of San Diego, Cal.

The Proposed Works of the Pueblo Gravity Water Supply Co.

A recent report to the Pueblo, Col., Gravity Water Supply Co., by Mr. J. D. SCHUYLER, C. E., of San Diego, Cal., treats of the development of a water supply

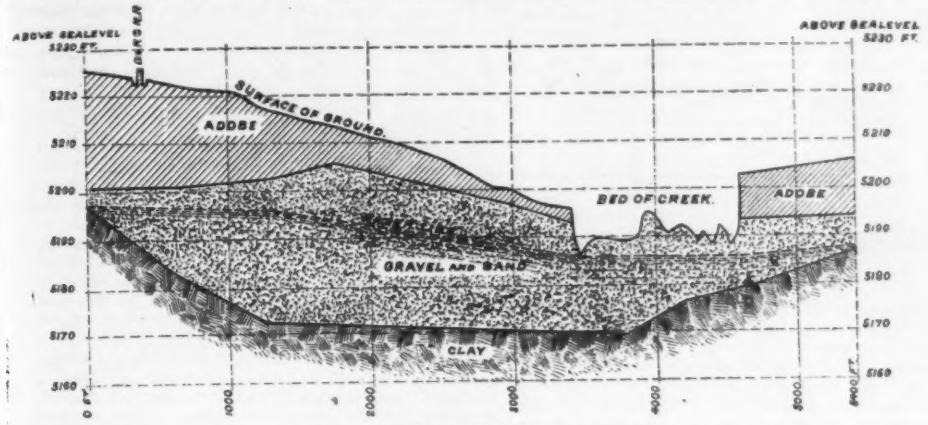


FIG. 1. CROSS SECTION OF VALLEY.

from the underground flow through gravel, and also of the use of California redwood for conduits. Those familiar with hydraulic engineering works and plans in the West know that at present these are very live questions: the first because of the great value of pure and constant water supplies in the West, and the second because of the need of a material for supply conduits which shall have all the desirable sanitary qualities, and at the same time be light for transportation and capable of withstanding high pressures.

Before considering Mr. SCHUYLER's report, it seems proper to say a few words about the sub-flows adjacent to those Western streams which generally become dry, or nearly so, in the summer, and thus, in themselves, unavailable as soures of supply, unless they are supplemented by large reservoirs for the poundage and storage of the surplus water of the wet season.

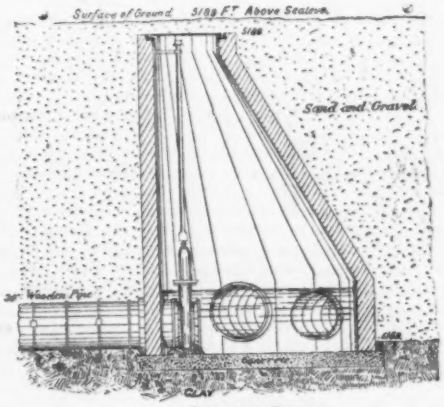
Briefly stated, the principle involved is this: The old beds of the streams under consideration were wider than the present ones, and have become partially filled with gravel; so a section at right angles to one of the present streams shows beneath its bed, and at its sides an extent of gravel many times its own cross-sectional area. This is well illustrated by Fig. 1. The water of the stream permeates the surrounding gravel, so when the dry weather comes on the stream may be nearly or quite dissipated. The bottom of the old stream bed is very nearly or quite parallel to the present bed. Consequently the water in the gravel is continually flowing in a course generally parallel to the stream. It can, therefore, be intercepted either by a watertight submerged dam carried across the old stream bed or by drain pipes. For domestic water supplies these underflows are very desirable, as the water has undergone a thorough filtration. The method to be employed for intercepting the flow depends, of course, upon local conditions. In the case before us drain pipes were used in the manner now to be described.

Mr. SCHULYER was called by the Pueblo Gravity Water Supply Co. to examine and report upon a plan which, as appears from the report, had already been carefully worked out by the company's engineer, Mr. D. C. HENNY.

The proposed source of supply is the under flow of the Fountain qui Bouille, and the location of the development works is near Wigwam, a station on the Denver & Rio Grande R. R., about 19 miles above the mouth of the stream at Pueblo. At this point the surface has an elevation of 5,200 ft. above sea level, 540 ft. above ordinary low water level in the Arkansas River at Santa Fé Ave., Pueblo, and 525 ft. above the business streets of the city. The company has already purchased sufficient land at this point to enable it to develop the proposed supply.

Fig. 1 shows a cross section of the valley on the line of the proposed gallery or drain pipes. The total cross-sectional area of the gravel below the permanent water line is 66,000 sq. ft., with an average depth of nearly 14 ft. of gravel. At present but 32,000 sq. ft. will be drained, or 2,400 ft. measured across the valley. This will leave some 1,600 ft. on the west side not directly drained, which will permit a future extension of the pipe. The average inclination of the valley is 30 ft. per mile.

The estimated daily yield from the works is from



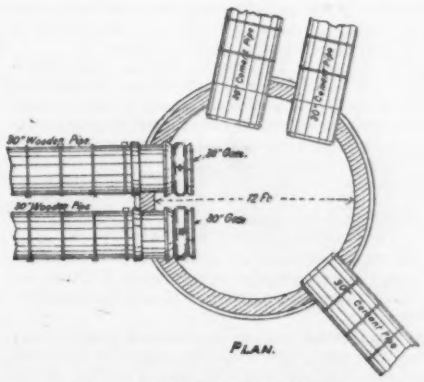


FIG. 2. COLLECTING WELL.

10,000,000 to 12,000,000 galls., on the assumption that the voids in the gravel are 30% of the mass, that the mean velocity of the flow of water through the gravel is 7 ft. per hour, that the gravel bed extends 25 miles up stream with an average width of 2,000, and depth of 12 ft., and that the total volume of water in the body of gravel is 7,000,000,000, or a daily supply, without replenishing, of 20,000,000 galls. About 200 ft. of pipe already laid, at 3½ to 6 ft. below the surface has developed a daily flow of about 500,000 galls.

The plan devised includes a collecting well 12 ft. in diameter, shown by Fig. 2, with a 36 and a 30-in. cement drain pipe extending from each side into the gravel, there being 800 ft. of 36 and 3,600 ft. of 30-in. pipe. The pipe will be laid with open joints near the clay bottom, on "track," as shown by Fig. 3. After the drain pipe has been laid it is proposed to drive a tight line of sheet piling below it, and to build a puddle dam as high as the present water level.

The first 5,630 ft. of the supply conduit will be double, 30 ins. in diameter, on a hydraulic grade with a fall of 1.1 ft. in 1,000; the remaining 70,140 ft. will be 24 ins. diameter, laid to hydraulic grade, with a fall of 3.15 ft. in 1,000.

The daily capacity, as designed, will be 11,000,000 galls.

Regarding the kind of pipe for the conduit and its merits, Mr. SCHUYLER says:

I have recommended the use of 5,630 ft. of 30-in., and the remainder, 70,140 ft. of 24-in. pipe, to be made of California redwood staves, built continuously in the trench and banded with round steel bands. This recommendation has been made for the following reasons:

First—After thoroughly investigating the history of wooden pipe as laid for 7 years past in Colorado, and after examining a number of lines in use, I have come to the conclusion that if the bands are properly coated and the pipe kept full of water it is practically indestructible, and certainly has a longer life than sheet iron or steel-riveted pipe.

Second—The interest on the *difference* in cost between wood and cast-iron pipe of the same capacity will replace the wood pipe every 10 years, which I think is but a fraction of the life of wood pipe, and therefore it would be a prodigal waste of money to put the amount of capital necessary to lay cast-iron mains into the enterprise.

Third.—The wood pipe is cleaner, does not become foul, does not rust, does not fill with tubercles that diminish the capacity year by year, has no yarn to rot and contaminate the water, will not break by settlement, will not burst so readily under water hammer, and so long as it lasts is in every respect cleaner and more desirable.

It has been made to stand 189 ft. head, without leaking or double the maximum pressure on your pipe. California redwood is so much better adapted to that purpose than any other wood available, that I recommend that material.

This kind of pipe has been used quite extensively by the Denver (Col.) Water Co., and is illustrated in ENGINEERING NEWS, vol. xix., p. 333; vol. xx., p. 222 and p. 240.

To equalize the flow of water the pressure in the distributing mains and to provide a reserve supply a 7,000,000-gall. reservoir is to be built 19,000 ft. from the Arkansas River, and this will be the terminus of the conduit proper. From the reservoir to the city main at Tenth street the supply main will have a static head of 113 ft., and heavy sheet-riveted, asphalt-dipped pipe is recommended. Sufficient ground has been selected to build two 7,000,000 reservoirs, but Mr. SCHUYLER thinks a second, in another part of the city, would be preferable.

Fig. 4 shows a section of the reservoir embankment and a part of the roof. It is proposed to pave the slopes with rock or slag, covered with 1 in. of asphaltum. The roof is to be of corrugated iron, on wooden girders, supported by crosoted posts. It is designed to exclude light and prevent the growth of algæ.

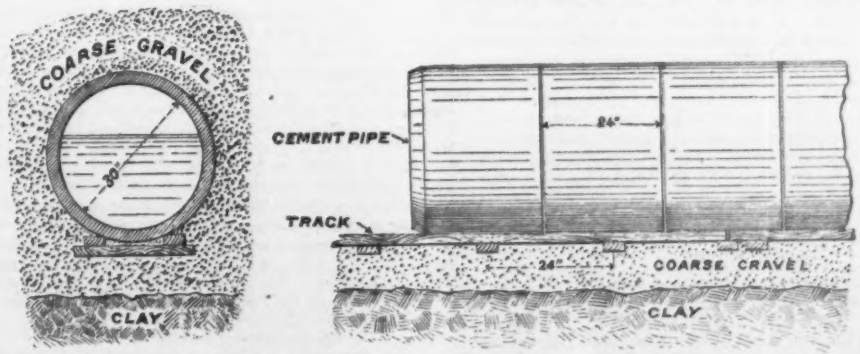


FIG. 3. CEMENT GALLERY PIPE AND TRACK.

At present Pueblo is supplied from the Arkansas River by pumping, the works supplying the north side of the river being owned by the city, and those on the south side by the Colorado Coal & Iron Co. The report states that the river is a turbid stream, "carrying a fine silt in suspension, which seems to defy all the efforts thus far made to settle and clarify it." The present population is said to be nearly

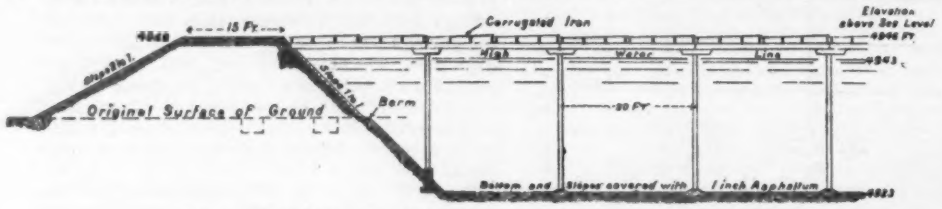


FIG. 4. SECTION OF RESERVOIR EMBANKMENT AND ROOF.

30,000. No estimate of the cost of the proposed works is given, nor is it stated whether the city has given the company a franchise for works, or contracted with it for water.

The New Brooklyn Bridge Terminals.

Last May the problem of better facilities for handling the traffic on the Brooklyn bridge was submitted to a Board of Experts, made up of the following named gentlemen: Mr. SAMUEL SPENCER, Prof. GEORGE W. PLYMPTON and Mr. C. W. BUCHHOLZ, C. E. This Board has now submitted the following report to the trustees of the bridge, which we reprint in full, reserving for another issue any comments we may have to make upon it.

Numerous plans were submitted, and the Board as readily as possible examined them, and listened to many oral statements in explanation. It has also examined with care the reports of the previous Boards of Experts, together with the complete data furnished by Mr. C. C. MARTIN, the Chief Engineer and Superintendent, and Mr. J. LEVERICH, Assistant Engineer, covering all the suggestions made from time to time and the results of experience in operating the bridge railway since its opening.

Much time has also been consumed in examining the practical working of the line, a course found to be necessary to a thorough understanding of the mass of detail involved in the question.

THE PRESENT SITUATION.

The railway traffic for the last year amounted to 37,667,411 passengers, or an average of over 100,000 per day for the entire year. The maximum number in one day was 161,405, and while no data are obtainable as to the number moved one way in one hour on that day, it is probable that it was about 16,000. From 1883 to 1889, inclusive, the number of passengers transported each way each hour of the day was determined by actual count for certain days, taking one of these days for each year. To show approximately how the maximum number one way in one hour has increased, we have the following:

Year.	*Maximum passengers per hour, one way.*
1883	1,560
1884	4,620
1885	4,725
1886	7,870
1887	10,068
1888	11,413
1889	13,355
1890	13,687

The days selected were probably not those of the largest travel for the respective years, nor do the figures in any case likely represent the maximum in one hour for those days, as the count was taken hour to hour, as from 7 to 8 and 8 to 9 A. M., or 5 to 6 and 6 to 7 P. M., whereas the greatest rush is probably from 5:30 to 6:30 P. M. From these data, and from the actual number of passengers transported each day since the bridge railway was opened, certain deductions have been made by the officers of the bridge as to what the traffic may be per year, per day, and the maximum in one hour, in future years, if conditions remain unchanged. Whatever may be the result years hence as compared with those deductions, one significant fact presents itself for the year 1890. Mr. LEVERICH's calculations for 1890 were:

For the year	37,000,000	passengers.
For the day of largest traffic	109,000	"
For maximum for one hour	21,000	"
The report shows for the year	37,667,411	"
For the day of largest traffic	161,405	"

And yet it is very improbable that 21,000 were carried in any one hour. The reason for this is probably to be sought not in any want of correctness in the basis of estimate, but in the fact that the facilities for handling passengers *per hour* have not kept pace with the general growth of the traffic. The business was to be had, but in the hours of maximum movement it was driven to other channel by want of facilities. The present capacity of the bridge trains, one way, is about 16,000 passengers per hour, or 40 trains of 4 cars each, with 1 min. 30 sec. headway and 100 passengers per car.

PLANS FOR IMPROVEMENT.

To increase this capacity it is necessary either to reduce the headway or to increase the number of cars per train. To what point either of these two things is practicable can be determined only by trial and experience. Numerous and widely different opinions and suggestions have been presented as to both, with reasons and conclusions almost as widely divergent and conflicting as they have been numerous.

These have all been considered and weighed by the Board, with the unanimous conclusion that the relief must be sought rather in the increase in number of trains—that is, by the reduction of headway—than in the number of cars per train. Nothing has been more thoroughly demonstrated in railway practice than that when regularity and promptness are required—and on the bridge they are essential to success—shortness and lightness of train are important elements, and that as the train is lengthened, it is less under control and more difficult to start, stop and handle, with certainty and safety, especially when heavy grades are to be dealt with.

It is doubtful whether it will ever be desirable to run trains of more than five cars each upon the bridge, and for the present it is believed that the best results can be obtained with four. If this be true, then more than 40 trains per hour must be dispatched from the termini, and the problem is to recommend a plan for terminal stations which will enable them to be dispatched at the minimum intervals of time and space at which they can be moved regularly and safely across the bridge. When this is accomplished the maximum capacity of the railway will be reached, and no alterations of terminals should provide for less. Several methods have been suggested, none of them either entirely new or recent.

1. LOOP SYSTEMS.

The loop systems, particularly for the New York terminus, possess many attractive features, such as the reduction of the number of switches, the dispensing with locomotives and with switching tracks over the street, the loading of trains in the same position in which they are unloaded and the keeping of the current of car movement always in one direction without switching.

Some plans provide for a single loop line, with incoming platform on the exterior and the outgoing platform on the interior of the curve. The advantage of this so far as relates to handling the passengers would be that the incoming and out-going passengers would move out of and into the cars in the same direction, and without conflict, but it is evident that this would not save sufficient time to secure the required increased capacity over the present single-platform system without greatly lengthening the train; and the only elasticity in such a system to meet the hourly fluctuations and the constant growth of traffic would be in the number of cars per train. This, in the judgment of the Board, would not give satisfactory results in practice.

Other loop systems contemplate two or more platforms, with tracks between, these tracks converging to the main line as rapidly as possible on each side. This plan would meet fully the requirements as to unloading and loading trains in sufficiently quick succession, and it also admits of the location of platforms near the entrance at Park Row, New York, thus saving a long walk for passengers.

No device has been submitted to the Board, however, for the operation of cable trains around such a loop, which has been sufficiently developed in practice to warrant its adoption now. It is quite clear that the main cables cannot be used around such loops, and if auxiliary ones are used they must either be dropped and be retaken on straight lines of track at the platforms or else some new device must be used by which they can be retained by the grip-car while the train remains motionless.

To locate the platforms on straight lines, parallel with Park Row, and complete the loops, involves the purchase of such large amounts of expensive real estate as in the judgment of the Board to be prohibitory, and to locate a sufficient number of platforms on curves of such short radius as to reduce the cost for real estate to within moderate limits seems entirely impracticable.

2. RECTILINEAR SYSTEMS.

The head-house system, so called, would have many advantages for the New York terminus in bringing the platforms nearer to Park Row, facilitating connection with the elevated railroad and the street, and in avoiding the projection of switching tracks beyond the building line of the terminal station on Park Row; but the delays—to say nothing of the possible dangers—in switching loaded trains in the face of each other and over the necessary crossings, forbids its serious consideration where trains are moved by cable power, approaching the station on a descending grade of over 3 per cent., and at the very short intervals required between trains to move the heavy traffic of the bridge.

This leaves but one system of terminal handling—substantially the one now in use—to be considered. Despite the many adverse criticisms which have been made upon it, its defects have been not in the principles employed, but in the want of adequate additions to meet new requirements. The system is not wrong, either for safety or expeditious movement, but it has not been developed as the traffic grew. It is the only one which experience has justified in the operation of the bridge railway, and this experience is, in many particulars, of governing importance in forming conclusions as to what is best for the future.

This railway is the only one which has successfully operated a cable line upon heavy grades with trains of four cars, and of more than 80 tons in weight, and it is probably carrying safely more passengers per day and per hour at certain periods of the day between two given points than any other transportation line in the world. The apparatus for accomplishing these results has been of gradual development, and, while confessedly not perfect, has had remarkably few failures when not overcrowded or taxed, especially when the conditions under which it is used and the enormous work it is called upon to do are considered.

The plant should be so enlarged, and parts duplicated, as not to be overtaxed by more than double the present traffic. With the overstrain removed, and emergencies better provided for, the chief objections to the system will disappear. The enlargement, to be successful, must be upon the lines of experience. The volume of travel is of a size and a character which admits of no serious interruption. No experiments can be tried with the machinery which hauls it, and no plan of improvement is permissible which endangers its continuity.

RECOMMENDATIONS.

Looking at all these facts the Board unanimously recommends:

1. That the terminals be enlarged, both in New York and Brooklyn, substantially as shown in the accompanying plans marked 1 and 2, the incoming and outgoing platforms to be not less than 20 ft. in width and 225 ft. in length, with a track on either side of each.

2. That two gantleted tracks be laid on each line of railway, the one leading to the north side and the other to the south side of the incoming and the outgoing platforms respectively, thus avoiding the regular use of switches by loaded trains, and reducing to the minimum the possibility of derailment from broken tracks.

3. That two cables be used—one for each track of the gantlet—both to be run regularly during the busy hours of the day, and the second one, when not in use, to be kept ready for immediate service in case of accident or other emergency. These two cables should be operated by entirely separate machinery, so that the efficiency of one is in no way dependent upon any part of the apparatus connected with the other.

4. That as soon as possible the grip apparatus be so arranged that the cable can be dropped and picked up at any point on the line.

5. That the tracks at the New York terminus be raised to improve the grade approaching the platforms and to admit of a large waiting room and entrance hall beneath; this waiting room to communicate by wide platforms and passageways with the bridge to City Hall Park, the Manhattan Elevated Railway station, and the entrances from Park Row and William St., and to furnish an inclosed place in which passengers can in comfort wait, either from choice or necessity. It is recommended also that elevators be put in at Rose St., connecting with this waiting room, as an inducement to passengers coming from between the bridge entrance and East River to enter the station at the east end and take the front cars which are furthest removed from Park Row. It is believed that this will add largely to the bridge travel. Two elevators, of a capacity of 50 persons each per minute, or 6,000 per hour for the two, will be sufficient at present, but the plans should provide space for two additional ones, to be built when needed.

6. That the whole of the triangular block north of the bridge, and between North William St. and Park Row be acquired by the bridge trustees and the Manhattan Ry. Co., in such proportions as may be agreed upon, and the part not required for the enlargement of the Manhattan Co.'s City Hall station be used jointly as a means of communication between the two railways, and for access to the bridge trains, roadway and promenade on the north.

7. That the footbridge to City Hall Park and the stairways thereto be widened.

8 That the Brooklyn station be located between High and Sands streets, adjacent to and parallel with Washington street, as shown on plan 2, and that sufficient property be acquired for yard and storage purposes in extension of the present yard up to Tillary street. This location is suggested because it accommodates with least change of

the transportation lines which bring traffic to the bridge; it requires less outlay for real estate than any other convenient and suitable one, and it accomplishes the object with least possibility of conflict and delay.

9. That, as a means of affording needed access to the bridge for all classes of its traffic, the entire block bounded by High, Sands and Fulton Sts. and the bridge station should be acquired and opened as a plaza, and that Liberty St. be widened to 80 ft. and extended as shown on plan 2. The location of the station as proposed would enable the Union Elevated R. R. to maintain its connection with the bridge substantially as now. The plaza would afford ample ingress and egress for the roadways,

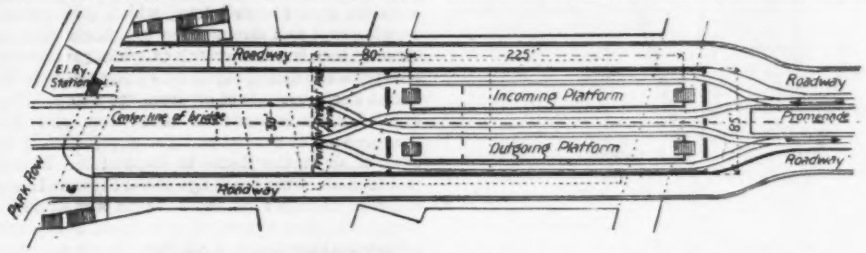


FIG. 1. PROPOSED ARRANGEMENT OF TRACK FOR NEW YORK TERMINUS.

and suitable terminals for all the Fulton St. surface railways, and the connection with the Kings County Elevated line could be made by overhead gallery from Fulton St.; or, better still, the tracks of that company could be placed upon Liberty St. from Tillary St. to the station and a shorter footway for passengers thus obtained.

10. That the improvements be made without delay.

CONCLUSIONS.

The Board believes that these plans, if adopted, will meet all the substantial requirements of the case, at the minimum outlay for property consistent with the objects in view, removing at the same time, so far as is now practicable, the delays and annoyances to the public, and the loss of revenue to the bridge, incident to the present limited facilities.

The headway between trains can be reduced to 45 seconds, increasing the capacity of the railway with 4-car trains from 16,000 to 32,000 passengers per hour, or with 5-car trains to 40,000. If, as is probable, the headway can be made 40 seconds, the capacity for 4-car trains will be 36,000, and for 5-car trains 45,000 per hour, assuming that passengers insist upon crowding the trains to the extent of 100 per car rather than wait. Before this limit is reached the growth and distribution of the population in the two cities will be such as to demand other means than this one bridge for quick transit between them, and the problem will likely have assumed such different phases that no calculations upon it now would be of much value.

Only two objectionable features of the present plan remain, if these suggestions are carried out: The curve

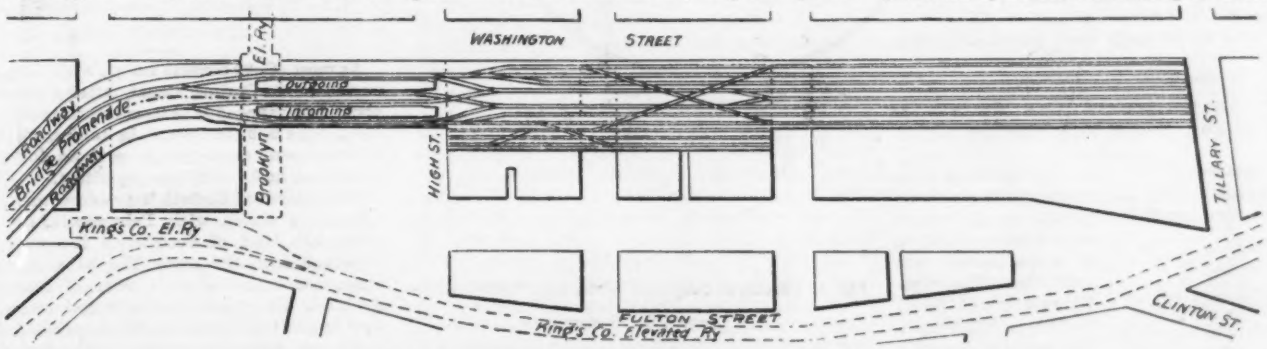


FIG. 2. PROPOSED ARRANGEMENT AT BROOKLYN.

near the Brooklyn terminus, and the use of engines in the building and over the street in New York. The former is not very serious, and is far preferable to the inferior location of the terminus, and to such a disturbance of railway connections, both elevated and surface, as would result from straightening the line. The latter is more important, and while the Board has not seen its way to a recommendation for its immediate removal, it believes that a plan can be devised for the purpose, not inconsistent with the suggestions of this report, and that the subject should be pursued to a conclusion by the bridge management.

"Parties have appeared before the Board with plans for transferring the empty trains from the incoming to the outgoing platforms by means of circles of very short radius to be located at the west end of the platforms, and offering, at their own expense, to make the necessary demonstration, on a large scale, of their practicability. It is suggested that the bridge trustees, by such method as seems best to them—either by the offer of premiums to others, or by experiments conducted on their behalf by the officers of the bridge—endeavor to secure the use of suitable appliances for this purpose, and that the New York terminus be planned with a view to the possible adoption of a system of circles instead of the switching tracks, all within a building to be erected on the land now owned or to be acquired under the suggestions here made. If such a system can be adopted it will be possible to move the platforms nearer to Park Row, which is very desirable, and if, by that time, it is found expedient to use three platforms to still further reduce the headway of trains, the track floor of the building can be made to project over the roadways for a part of its length and width be thus obtained for the third one.

Until the tail switching into the street can be eliminated it is not believed that any desirable or suitable building can be erected at the bridge terminus on Park Row from which rentals can be obtained; but such a building, with the locomotives dispensed with, could and should be made not only a handsome and fitting portal to the bridge, but also a source of revenue from expensive real estate necessary for the purpose of the bridge, but otherwise unproductive. The services of an architect have not been required, as no ornamental buildings are suggested, and it is thought best not to incur any expenses for detail plans and drawings until it is decided by your Board whether the recommendations are to be approved or modified. When such decision is made, this can safely be left to the officers of the bridge.

Japanese Lacquer for the Protection of the Hulls of Ships.

In the last number of the Proceedings of the U. S. Naval Institute, Lieut. J. B. MURDOCK, U. S. N., contributes a valuable article on the subject named in the above title. The author, after noting the great importance of protecting from corrosion the hulls of iron and steel ships, gives at length the experiments of the Japanese naval officers in applying their famous lacquer to ships' hulls. He also notes in detail the source of this lacquer, the method of gathering and preparing, and quotes the analysis of specimens from various sections, as given by Prof. H. YOSHIDA, of the Imperial University of Tokio, recognized as one of the best authorities on lacquer in Japan.

Without going into this detail, for which we would refer interested readers to the proceedings quoted, the general results of its application to ships can be stated as follows: The idea was suggested to a Mr. HOTTA, a lacquer manufacturer of Tokio, by the fact that lacquered objects that have been subjected to sea water were found to be practically uninjured after considerable time of immersion. Experiments were made on ship plates at the Yokosuka Navy Yard and were satisfactory enough to be followed by a practical test upon the bottom of a ship. In June, 1886, 1,200 sq. ft. of the bottom of the *Fuso-Kan* were so treated. The ship was docked in September, 1887, and the showing was so good that orders came from the Admiralty to lacquer the whole bottom. In December, 1888, and in June, 1889, the ship was again docked and the lacquer found still satisfactory. At each docking a coat of anti-fouling paint was applied. In April, 1890, the *Fuso-Kan* was docked once more, and though the lacquer was almost perfect, it was, for some unknown reason, scraped off and the bottom painted.

Since then, says Lieut. MURDOCK, many other vessels of the Japanese navy have been thus coated. Experiments are now in progress with an anti-fouling lacquer that promises well. The contractors guarantee a lacquer coat for three years, and the cost of applying it to the *Charleston*, for example, is estimated at $2,000, at 13 cts. per sq. ft. This is the Japanese price, the lacquer might cost twice as much here. Including docking for 9 days the total cost of thus protecting the *Charleston* would be $6,900. Plates thus prepared are now at the New York Navy Yard under test. Lieut. MURDOCK estimates that the lacquer process, assuming that it will last 3 years, is cheaper in the long run than painting. His paper contains much valuable detail as to methods of application, etc.

Legal Decisions of Interest to Engineers.

Rule of Damages in Condemnation Proceedings.—The rule by which the amount of damages to be recovered in condemnation proceedings is computed is to ascertain the value of the tract before the portion taken is appropriated, and the difference between this and its value after condemnation is the measure of damage. (Louisville & N. Ry. Co. v. Ingram, Court of Appeals of Kentucky, 14 S. W. Rep., 534).

Opinion Testimony in Flowage Case.—In an action for the alleged negligent construction of a railroad embankment so as to obstruct the flow of a river in times of high water, thereby flooding plaintiff's land, a non-expert witness who has been familiar with the land for 20 years, and who has testified to the facts relative to the flood and to the construction of the embankment, may also give his opinion as to whether or not the embankment did in fact obstruct the flow of the river on the occasion complained of. (Gulf, C. & S. F. Ry. Co. v. Locker, Supr. Ct. Tex., 14 S. W. Rep., 611.)

Necessity for Flagman at Railroad Crossing.—It is a proper question for the determination of a jury whether or not from all the facts and circumstances in a given case it is negligent for a railroad company to fail to place a flagman at a crossing, but where it is charged that such failure was negligent it is proper to show that the person who complains of such negligence knew that there was no flagman at the crossing, and that he could see for himself, by the exercise of reasonable care, all that the flagman could have seen to warn him off, and this evidence is properly for the consideration of the jury in determining the questions of negligence and contributory negligence. (Annaker v. Chicago, R. I. & P. Ry. Co., Sup. Crt. of Iowa, 47 N. W. Rep., 68.)

Liability of Railroad Company for Incidental Damage by Fire.—Where it is shown that a fire has been set by the negligence of a railroad company in providing spark arresting appliances the company will be held liable for all damages resulting from the fire, and where one in good faith attempts to help his neighbor to save property threatened by the fire and in doing so is unavoidably burned he may recover for such injuries as he sustains. (Liming v. Illinois Cent. Ry. Co., Sup. Crt. of Iowa, 47 N. W. Rep., 66.)

Liability of Railroad Company for Unblocked Frog.—A railroad company is liable for the death of a brakeman who is killed by reason of having his foot caught in a frog if it appears that his foot could not have become so caught had the frog been properly constructed and properly protected. The railroad company is not only bound to exercise ordinary care in selecting its switches, but it is bound to exercise ordinary care in keeping them in a reasonably safe condition. (Brook v. Chicago, R. I. & P. Ry. Co., Sup. Crt. of Iowa, 47 N. W. Rep., 74.)

Responsibility of Railroad Company for Defective Couplings.—Where a railroad company permits a caboose which is out of repair to continue in service, it is liable for all damages sustained by employees who are injured by such defects without notice of them. Where a car is used with a draw-head higher than the draw-head of the caboose, so that a crooked link is necessary to make a coupling, an inexperienced brakeman, who has not been instructed as to the necessity for a crooked link, and who in response to an order given in haste to make a quick coupling attempts to make it with a straight link and is thereby injured, may recover from the company for its negligence in failing to have him properly instructed. (St. Louis, I. M. S. Ry. Co. v. Higgins, Sup. Crt. of Arkansas, 14 S. W. Rep., 653.)

Brick-Dust Cement.

According to a writer in *The Manufacturer and Builder*, ordinary brick-dust, mixed with lime and sand, affords a tolerably good substitute for hydraulic cement, the brick-dust mortar being decidedly, though not strongly, hydraulic. In his "*Engineer's Pocket-book*" TRAUTWINE recommends its employment in all cases where hydraulic cement cannot be obtained. In experiments made by him with mixtures of brick-dust and quicklime, he found that blocks of one-half inch in thickness, after immersion in water for four months, bore without crushing, crumbling, or splitting a pressure of 1,500 lbs. per square inch. He appears to have been thoroughly convinced of its merits, since he recommends the addition of small quantities of it to ordinary cement and water. He believes that the addition of even as small a proportion as one-tenth as much brick-dust as sand to our ordinary mortars would prevent the disintegration so generally visible in the mortars used in the masonry of many of our public works. The expedient to which we draw attention is not a new discovery, but we venture to think that brickmakers and builders in this country might avail themselves of it much more extensively than they do. The use of brick dust with lime and sand is aid to be very extensively and successfully practiced in the Spanish dominions in America as a substitute for hydraulic cement. Mr. F. B. MILES, of Philadelphia, who has spent a number of years in Cuba engaged in engineering work, and who has had abundant opportunity of testing the merits of the material, states as his experience that it is in all respects superior to the best Rosendale hydraulic cement for culverts, drains, tanks or cisterns, and even for roofs, whether for setting flat tiles or for making the usual tropical flat roof. It is known in that country as a regular article of commerce. The proportions used in the manufacture are approximately one of brick-dust, one of lime and two of sand, mixed together dry and tempered with water in the usual way. Mr. MILES expressed the opinion some years ago that as this material could be produced at a lower cost than cement, it would prove a profitable plan to utilize the waste and broken bricks by setting up pulverizing mills in all large brick yards.—*American Architect.*

The Pintsch Compressed Gas System of Lighting Buoys and Beacons.

The Pintsch compressed gas system, which is becoming familiar from its use in lighting railway trains, has been applied also with much success abroad to the lighting of buoys, beacons and lightships. The essential principle of the invention is very simple. The buoy itself serves as a gas holder, and may be made of any desired size, according to the length of time it is desired to have the lamp burn with one filling. On top of the buoy is a light framework, elevating the lantern to a height of about 12 ft. above the water, and a weight is attached to the base of the buoy, serving to keep it upright.

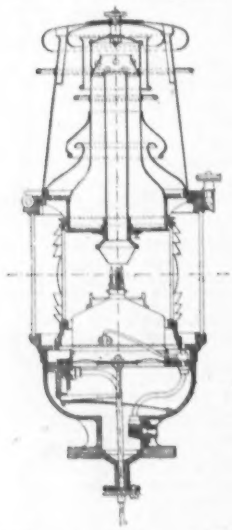


FIG. 2. — Section of Wind-Proof and Wave-Proof Lantern for Use on Buoy.

The buoy illustrated in Fig. 1 is made of large diameter and small height, for use in shallow water. It is anchored by a chain attached to the base in the usual manner. On the top of the buoy is an attachment to which connection is made for filling the buoy. A pipe also leads from this to the lantern. The buoy is built of wrought-iron, but without seams or rivets, so that there is no risk of leakage. The capacities of buoys made for use in Europe has been such as to give the lamp a duration of burning between fillings of from 30 to 120 days. The gas is stored in the buoy under a pressure of about 9 atmospheres, and each cubic foot of capacity gives about 24 hours' duration to the light. Larger sizes can of course be made when desired. The buoy is re-filled when necessary by a tender carrying a tank of the compressed gas, from which a hose connection is made to the buoy.

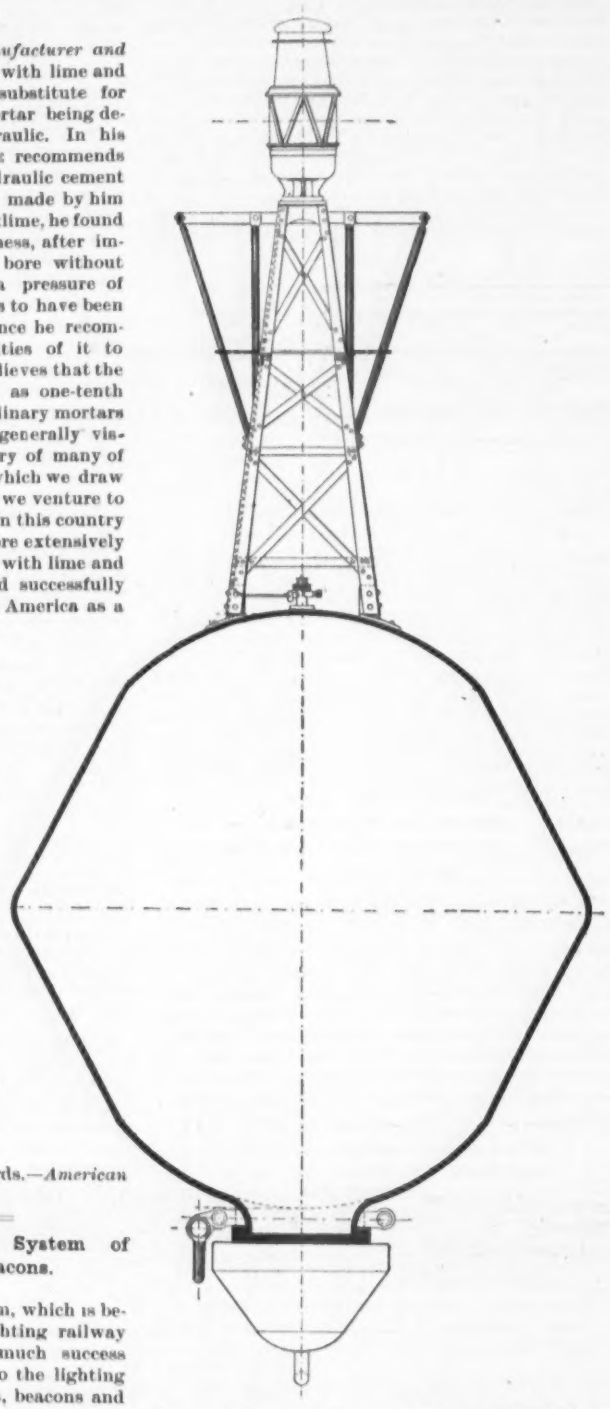


Fig. 1. Section of Buoy with Lantern for Pintsch Compressed Gas System.

The principal feature of interest in the design of the apparatus is the regulator and lantern. The regulator is the same that is used for car-lighting. It is shown at the base of the lantern in Fig. 2. It consists of a closed chamber in which the gas is held at the pressure it is desired to use for burning (about that produced by a ¼ in. column of water). The upper part of this chamber is closed by a flexible diaphragm, and the pressure on this is balanced by a small spring. To this diaphragm is connected a lever which moves a valve, opening or closing the pipe which admits the compressed gas from the interior of the buoy. The burner of the lantern thus takes its supply from the regulator chamber at a constant pressure, no matter what the pressure of the gas inside the buoy.

The lantern is devised to give the brightest light and at the same time avoid any possible extinguishing of the flame by winds or waves. The burner is surrounded by a Fresnell lens, which collects the diverging rays and directs them in a horizontal plane Around this is a framework of glass, protecting the lens from the salt spray and forming a double chamber to keep currents of air from the flame. The top of the lantern is made of sheet iron, and the air passages are so curved and protected that a direct draft of air on the flame is impossible. In experiments made some years ago at the Stevens Institute of Technology one of these lamps was lit and subjected to the current of air from a Sturtevant blower making about 4,000 revolutions per minute, and also to a jet of water from a fire hose. Each of these tests was sustained perfectly by the lamp, according to the report of President HENRY MORTON to the Light House Board.

The considerable expense of periodically filling these buoys has been probably the chief reason why they have been slow to come into use, especially in this country. The following table shows the number in use by various countries, according to the latest available returns.

COUNTRIES.	*Buoys.*	*Beacons.*	*Light ships.*	*Filling Stations.*
Germany	6	4	..	..
England	35	14	3	5
Netherlands	13	2	1	1
France	13	3	..	1
Portugal	5	..	..	1
Denmark	7	..	..	1
Russia	4	..	..	..
Tunis	10	..	..	1
Swedish Navy	1	..	1	..
Austrian Navy	1	.	..	..
Italy	5	..	..	1
Spain	1	2	..	1
United States	12	2	..	1
Canada	8	..	..	1
Brazil	1	..	..	1
Argentine Republic	1	..	..	1
Egypt	64	42	..	2
Australia (Victoria)	2	2	..	1
Belgium	1	..	..	..
Totals	190	71	5	19

The Safety Car Heating and Lighting Co. of New York City control the Pintsch patents for the United States.

The Corinth Canal.

As most of our readers know, work has been resumed on the Corinth Canal, after a suspension of about two years, due to financial troubles. *Le Genie Civil*, in its issue of Dec. 27, in taking up the work in its present state briefly reviews the history of this canal, and it will bear repetition.

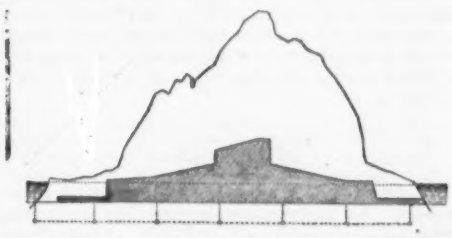
The Isthmus of Corinth is a narrow tongue of land connecting Attica with Peloponesia, and lies between the Gulf of Corinth on the west and the Ægean Sea on the east. The isthmus is 20,664 ft. wide, with a maximum elevation of 262.4 ft. above sea level. The work to be done, not including the dredging of the approaches on either side, amounted to the excavation of a trench containing about 12,350,000 cu. yds., with side slopes of 1 in 10, as at first fixed upon. The methods adopted for working this cut, at its commencement in 1882, were described in ENGINEERING NEWS of June 7, 1884. By the end of July, 1889, a total of 10,660,000 cu. yds. had been taken out; the average daily output up to this time being equivalent to 8,000 cu. yds. At the time the work was suspended in 1889, the total plant on hand included 13 locomotives, 700 large cars, 18 miles of broad and 4.8 miles of narrow gage railway, and 160 small earth cars. At this time the bottom of the trench, though very irregular, had a mean elevation of 16.4 ft. above the datum line.

Unfortunately the geological conditions assumed at the beginning of the work were not realized as the trench was opened. In the original project the earth portions of the sides were to be sloped at an angle of 1 to 1; the sandy portions 2 to 1 and for the central rocky mass a slope of 1 in 10 was deemed sufficient. One reason for the latter assumption was that shafts dating from the time of NERO remained with their sides intact and perfectly pre-

served, and the numerous borings made seemed to fully confirm the views thus formed. As the work progressed however, it was soon apparent that the greatest disorder prevailed in the stratification and rocky beds, and that the faults were numerous and dangerous.

The geology of the isthmus was carefully studied by M. FUCHS, who found that the ground pierced by the canal belonged to the pliocene period, and that the beds were essentially horizontal or slightly inclined. But these beds had been subjected to secondary movements which caused slight but constantly occurring dislocation of strata. In passing from the bottom to the top the several strata were blue clay, calcareous tufa and conglomerates. From a physical point of view the clay was compact and homogeneous, and the slope adopted would have stood well in the climate of Greece. But, on the other hand, in water, either agitated or calm, this clay disintegrated and the banks would be undermined, as a result of traffic in the canal, unless they were protected from this wash.

The calcareous tufa formation is composed essentially of a limestone, which alternates with clayey seams and with grit-stone conglomerates, passing exceptionally into a very hard pudding stone, of which the cementing material is a crystalline limestone. The conglomerates are distinguished from the calcareous tufas by an absolute want of order in arrangement. On the Corinth side especially they show several deep ravines and a predominance of gravel, sand and mud, deposited by fluvial action. Beds of clayey or calcareous material are rare in this



Profile of Corinth Ship Canal (the shaded area shows part remaining to be done).

formation. M. FUCHS, in discussing the geological accidents which have produced the isthmus, divides these accidents into two distinct classes: (1) A series of light or quick upheavals, which did not affect the general stratification, leaving the clay beds horizontal and favorably disposed for holding the slope. (2) The occurrence of numerous faults, of which 62 have been counted. The faults are only apparent on excavation but pass through the whole isthmus, and their pitch is very far from the vertical.

With this experience and study as a base, Messrs. SAINT YVES and FUCHS were appointed in 1887 a committee of experts to report upon the changes of plan made necessary by the altered conditions. Their conclusions were that the blue clay in the central mass would stand a slope of 1 to 10 above the water level, as this clay was homogeneous, compact and hardens with exposure to the air. But for the submerged part they recommended a protecting wall of hydraulic masonry, with a mean thickness of 6.56 ft., and founded 3.28 ft. below the bed of the canal and rising 6.56 ft. above the sea level. The total height of this wall was thus 37.72 ft. At the top of the wall there was to be a bench, 6.56 ft. wide, which would serve as a road and for removing any slight falls of earth from the sides. For the calcareous tufa, this same slope of 1 in 10 was recommended; but for the conglomerates a slope of 1 in 5, or even 1 in 1.5, were deemed necessary. Since 1887 the work done has shown no serious slips.

M. QUELLENEC, the present chief engineer, although generally approving of the plans given above, has, as a precautionary measure, adopted a minimum slope of 1 in 5 for sound tufa and clay above the water line. For the submerged clay he thinks a slope of 1 in 4 necessary, and this also permits him to somewhat reduce the thickness of the protecting slope wall. He also proposes to unite the slope walls at the foot by transverse walls of masonry 3.28 ft. wide and 4.92 ft. deep, extending clear across the canal every 33 ft. Between these transverse walls he would protect the bed of the canal by beton 1.3 ft. deep. With these changes in plan M. QUELLENEC estimates that the work remaining to be done in the body of the canal is represented by the following quantities:

General excavation	4,550,000 cu. yds.
Masonry laid in mortar	247,000 "
Dry stone slope wall on conglomerates	117,000 "

If to this is added the dredging work and the masonry still to be laid at the entrances to the canal, a sum of about $2,800,000 is required. Adding expenses of administration the total cost of the canal will be about $14,000,000, instead of $6,000,000, as originally estimated.

There is some considerable discussion as to the actual necessity of protecting the bed of the canal, as proposed above, and as to the thickness and character of the protecting wall. It is argued that this wall cannot possibly resist the slightest tendency to slip in the sides, and can in no way be regarded as a retaining wall. The points in dispute were finally submitted to Engineer J. DEUTSCH, of Vienna, and he commenced, last May, a study of the subject. He regards the transverse wall as entirely superfluous, as also the beton lining on the bottom of the canal. He argues that the cutting of the bottom by the current would rather be to the advantage of the canal, in increasing the waterway. He says the protection of the sides is necessary to prevent cutting and undermining under wave action. But he thinks this protection need only be superficial, as the clay is impermeable. He proposes a surface protection only, to keep the water from contact with the clay, and argues that a simple applied coating of hydraulic cement mortar is sufficient for this purpose. To fasten the mortar to the clay slope, however, he proposes to build posts of masonry about 30 ft. high every 33 ft., and connect these by two flat arches, one sprung from the sea level and carrying a coping or roadway 5 ft. wide, and the other spanning the middle space. The spaces between these posts and arches on the clay, would then be cut with a tool into crossing furrows about 3 ins. deep, and the mortar then applied directly to the clay. If cracks at any time appear the divisions of the general surface by the arches and posts will make repairs easy. Mr. DEUTSCH thinks that this plan will save 6 months of time and $800,000 in capital.

In the meantime the general works are being pushed, and the final decision as to the lining and slope wall is postponed 6 months, pending experiments on the disintegration of the clay and the plans proposed.

The New Water-Works of Colombo, Ceylon.

After discussing the subject since 1862 Colombo, the capital of Ceylon, has set about constructing serviceable water-works, says *Indian Engineering*. The present scheme is that of the late Mr. JOHN BATEMAN, engineer of the Glasgow water-works. Water is to be taken from a region 25 miles from Colombo, with a catchment area of 2,385 acres and an average rainfall of 161 ins.! The storage reservoir has an area of 176 acres, with its surface 360 ft. above sea level. Its full capacity is 1,373,000,000 galls. The impounding dam is an embankment 109 ft. high, from bottom of foundation to crest, with 72 ft. between ground level and crest. The width of the bank, at right angles to its axis, is 480 ft. at the bottom and 360 ft. at the top. The capacity of this reservoir, to the lowest outlet level, is equivalent to 6,000,000 galls. per day for 200 days. The waste weir is 100 ft. long by 8 ft. deep below the crest.

The entire catchment area is a dense forest and jungle, and to ensure that it will remain so, the whole area is reserved by the Government. But the reservoir site, and 50 ft. of a margin, has been entirely cleaned off.

From the "straining well" at the reservoir a 20-in. pipe delivers 3,000,000 galls. daily into a "gaging tank," 102 ft. above sea level, at the city. This pipe has a fall of 250 ft. in the 25 miles, and is fitted with air-valves at the high points and flushing valves at the low points on the line. The pipe is usually in an embankment and crosses 42 streams and drainage lines with openings of from 6 to 24 ft., and 14 with openings varying from 48 to 196 ft. in length. The 106 air valves are 4 ins. in diameter, and the 61 scouring valves are 6 ins. in diameter. There are also 48 special 20-in. stop valves and 44 special 8-in. valves. All of these require personal and constant attention.

The service reservoir in the town is 191 × 190 ft., and 40 ft. deep. It contains 8,500,000 galls. The walls are made of cement concrete, and are 19 ft. 9 ins. wide at the bottom, and 5 ft. 9 ins. at the water level. The concrete was put in place "quite liquid," and then faced with concrete cement blocks 10 ins. thick. There was evidently some serious trouble here, and the dimensions above given were afterward divided into 6 separate compartments, connected by arches on the ground floor. The floor and walls of all the compartments were lined with ¾ in. of an asphalt plaster. The later depth is 38 ft., with a capacity of 8,350,000 galls. The estimated population of Colombo is 130,000, consequently the average supply per head is 19 galls. daily. No cost is given in the article containing these points.

THE MANHATTAN ELEVATED RAILWAY SYSTEM carried, in December, 1890, 17,607,624 passengers. In the month of December, 1889, the number of passengers was 16,464,000. This is an increase for that month alone of 7.49%. The increase in the train mileage in the same month was 8.79%. While these figures are interesting to non-residents they are not needed by the traveler on the elevated systems in this city to convince him that the end is not yet, and that radical relief in the form of more roads can come none too soon.

THE ARCHITECTS OF THE WORLD'S FAIR have been appointed. Their names are given as follows: Adler & Sullivan, W. L. B. Jenney, S. S. Beman, Burling & Whitehouse, Henry Ives Cobb, all of Chicago. The outside appointments are: Richard M. Hunt, George B. Post and McKim, Meade & White, of New York; Peabody and Stearns, of Boston, and Van Brunt and Howe, of Kansas City. This is a magnificent array of architectural talent and the results should accord. They will be under the general leadership of Daniel H. Burnham, Chief of Construction, and John W. Root, Consulting Architect.

A NOVEL TRANSPORTATION RATE comes to us from India. A contemporary of that section quoting a note made by us on grain transportation in Malabar, translates American money into Hindustani equivalents, as follows: "This canoe will hold 5 tons and is poled down the rivers and canals by a man and a boy at the rate of 30 miles in 24 hours for 6 annas. This is about ½ pie per ton-mile." This is doubtless all right in India, but to the American reader suggests further subdivision of the ton-mileage rate—especially by the "boy."

THE WELDING OF ALUMINUM WITH GLASS is a discovery claimed by Mr. BRADFORD MCGREGOR, of Cincinnati, O. The press of that city says he has exhibited a large piece of aluminum with a glass tube in the center, and that "when turned on a lathe" the two appear as one homogeneous mass, without flaw or joint. As he proposes to use this combination instead of platinum in incandescent lamps, the discovery is important, if true, which we are much inclined to doubt.

THE STATE SURVEY OF CONNECTICUT is expected to be finished this year under Prof. W. H. BREWER, Rev. JAS. H. CHAPIN and Mr. JNO. W. BACON, the commissioners. The maps to be published, in 1892, will be issued in 26 parts, each about 17 × 12 ins., on a scale of 1 in 62,500. They will show contour lines, all lakes, rivers, streams, roads and railways, and also the drainage areas of each stream.

THE MARITIME CANAL CO., of Nicaragua, has a bill now before the U. S. Senate, as reported by Mr. SHERMAN from the Committee on Foreign Affairs. The object of this bill is to authorize this company, better known as the Nicaragua Canal Co., to issue bonds guaranteed by the United States for the building of the canal. The bill comes in the form of an amendment to the act of incorporation approved Feb. 20, 1889. The bill is accompanied by a long report; some of the more material provisions are as follows: The capital stock is to be limited to $100,000,000. Bonds are also to be issued to this amount, with 3% interest, payable quarterly, and secured by a first mortgage on the property and rights of the company. These bonds are to be issued to the company by the U. S. Treasury only as the work progresses. The bonds will bear the guarantee of the United States for the payment of interest and principal as it accrues, and the company is to issue no other bonds. If the company does not pay this in-

terest when due, it is paid by the Secretary of the U. S. Treasury, but the company is obligated to refund the money thus paid, with 4% interest annually until paid. For the sums paid the United States will hold a mortgage on all property and rights of the company; but it is stipulated that there can be no foreclosure until 5 years after the canal has been put into operation.

THE PLANS FOR WIDENING THE MCCOMB'S DAM BRIDGE were very properly submitted to the original engineer, Mr. A. P. BOLLER, at the suggestion of ex-Mayor HEWITT. Mr. BOLLER said that if the draw is made 80 ft. wide, as proposed by Mayor GRANT, the bridge with accessories would cost $1,600,000, whereas only $1,250,000 had been appropriated by the legislature. The legislature will probably be asked to make an additional appropriation.

A COMPOUND LOCOMOTIVE is being built by the Chicago, Burlington & Quincy R. R. at its shops at Aurora, Ill., under the supervision of Mr. G. W. RHODES, master mechanic. The engine will be of the two-cylinder type, very similar to the Michigan Central R. R. compounds.

TO OBTAIN A FOUNDATION for the 10-story office building erected in the "Swamp" at Gold and Ferry streets, New York, 1,100 piles were driven and then capped with concrete. The space covered by the building is 92 × 95 ft. The building is fire proof, and will be used mainly for storing hides. A system of miniature railways suspended from the ceiling enable heavy goods to be readily moved about the various floors.

THE NORTH RIVER BRIDGE, the one planned by Mr. GUSTAV LINDENTHAL, C. E., is now before a board of U. S. engineers in this city, the members of the board being Gen. H. L. ABBOTT, Gen. C. B. COMSTOCK and Col. G. L. GILLESPIE, U. S. Engineer Corps. The line of the bridge is given as starting at Broomfield and Twelfth streets in Jersey City, and landing at Twenty-third St. in New York. The board is to hear any objections made to the height and location of the bridge. No definite objections were made at the first meeting, but a postponement was asked for and granted until Feb. 27.

THE HART LAKE CANAL is nearly completed, says the Florida *Times-Union*. This canal was commenced by the Disston Land Co. last February, and will connect Hart Lake, near the Osceola County line, with the Big Econlockhatchie, the chief tributary of the St. John's River, above Ocklawaha. The purpose is to drain and reclaim a vast body of swampy but rich land. With this canal finished it will be possible, in a row-boat, to pass over inland waters from the Atlantic to the Gulf; starting at the mouth of the St. John's River and coming out at Punta Rossa, on the Gulf.

THE "SWORD-SHIP," designed by a Danish inventor reminds us somewhat of the "crabs" mentioned in Mr. FRANK R. STOCKTON'S "War Syndicate." The practical purpose is the same, *i. e.*, to destroy the motive power of the enemy's cruiser by crippling or removing the screw. As described, this new ship, of about 110 tons displacement, would be armed with a submerged sword 10 ft. long, and having serrated edges to prevent slipping. The vessel itself would have a speed of 25 knots or more, and be protected from projectiles by a heavy deck and by the fact that it could be partially submerged. Just how the sword is shaped and how it is to cut off the blades of the propeller of a heavy war ship, without sinking the attacking craft at the same time, is not clearly described.

THE "CHEAP ALUMINUM" that Prof. JOSEPH M. HIRSCH was supposed to manufacture out of common Chicago clay does not bear investigation, says the *Daily News* of that city. That journal has been pushing some inquiries of its own, and it finds that chemical analysis shows that in composition and general appearance Prof. HIRSCH'S aluminum is suspiciously like that made by the Pittsburg Reduction Co. The total output of the Professor's extensive new laboratory is also said to agree too closely with the amount purchased by a Mr. STRENITZ, of Pittsburg, who is in the dyeing business, and can have no use for aluminum in connection with his own pursuits.

THE OHIO-ERIE CANAL project is heartily advocated in the final message of Governor BEAVER, of Pennsylvania. After discussing the general features of the plan, he points out the importance of this work, coupled with a corresponding improvement in the Erie Canal, as a means of extending internal commerce and for defensive purposes on the lakes. The completion of this canal would establish a chain of inter-water communication between New York and New Orleans.

THE COLORADO COAL MINES produced 5,476,410 tons in the two years 1889-90, says State Inspector JOHN MCNEIL in his fourth biennial report. The coal production of 1873 was less than 70,000 tons; in 1890 it was 3,075,782 tons. Of this quantity the Las Animas mine produced last year 1,134,845 tons. The value of the coal taken out in 1889 and 1890, at the mines, was $10,408,930, and nearly 6,000 men are employed. The average value of the coal in the cars at the mines is $1.87 per ton, for 1890. The estimated average cost of producing the coal, including royalty, is $1.50 per ton at the mines.

FURNACE SLAG is being made into paint at the old Boonton iron works in New Jersey, under the patent of JAMES P. PERKINS, of Pullman, Ill. The New York *Times* says that as these iron works date from 1778 the accumulation of slag amounts to about 300,000 tons; and, owing to the wasteful management of a century ago, analysis shows that this slag yields "from 55 to 70% of oxide of iron." As a consequence, the Pequest Furnace Co. finds that it pays to rework it for iron, and the mineral paint made from it is said to be of an excellent grade.

TO PREVENT A CRACK IN ANY METAL FROM EXTENDING a small hole is drilled at each end of the crack. But it often happens that the crack extends farther than can be seen on the surface, even by careful inspection, and if the crack extends past the hole, the drilling will do no good. To determine the point where the hole should be drilled, the *Revue Industrielle* recommends wetting the surface with kerosene or other fluid oil, wiping dry, and immediately marking the crack with chalk. The oil that has penetrated into the crack exudes, and indicates with precision the end of the crack.

THE GERMAN IMPERIAL CENSUS, for Dec. 1, 1890, gives the following items: Population of Berlin, 1,547,485; Dresden, 267,000; Munich, 340,000; Cologne, 282,000; Hamburg, 570,000; Magdeburg, 202,000; Frankfort, 179,000; Strasburg, 135,000; Leipsic, which now has 293,000 inhabitants, will, by enlarging its limits on Jan. 1, have 352,000, and be the third city in size in Germany. The population of Berlin shows an increase of 452,000 in the last ten years, and of 259,000 in the last five. The average annual increase for the last five years is about 52,000.

THE Z-BAR STEEL TIES are to be tried on the Belgian State Railways, by order of the Minister of Railways. The ties designed for this purpose will be made of steel Z-bars about 4.4 ins. high, and will weigh about 220 lbs.; they will be used with the Sandberg "Goliath" rail, weighing 95.5 lbs. per yd., which has been adopted for the main lines of the Belgian State Railways. Ties of the same type, but of lighter dimensions, have been adopted by the Belgian National Society of Local Railways, and are in use on the suburban lines at Charleroi. They are to be used exclusively on the Congo Ry., and are to be tried experimentally on the Varsovienne Ry. in Russia; the Salonica & Monastir line in Greece, and on a new line in Turkey. An agency has been opened in England, and it is hoped to introduce these ties into the United States. The Z-tie was described and illustrated in ENGINEERING NEWS, Sept. 7, 1889, and Aug. 9, 1890.

A CONVENTION OF INVENTORS and manufacturers of inventions is to be held at Washington, D. C., in April, to celebrate the beginning of the second century of the American patent system. The organization of a National Association of Inventors is also proposed. Particulars of the convention may be obtained from Mr. J. E. WATKINS, Smithsonian Institute, Washington, D. C.

THE TUNNEL of the Great Northern Ry. at London, England, in the construction of which steel bars were used for temporary lining, is 26 ft. diameter in the clear, and the material through which it is driven is the London clay. The steel lining was described in ENGINEERING NEWS, Dec. 20, 1890.

A COPPER-ALUMINUM ALLOY, says *The Engineer*, has lately been tested at Chalais, in the department of aerial navigation, with some surprising results. Nearly pure aluminum and ordinary copper conducting wire were alloyed and rolled into sheets 1 mm. thick, and from these strips were cut 5 mm. wide. The results of the various percentages in the alloy were as follows:

Composition		Spec. grav. Calculated.	Spec. grav. Determined	Tens. strength kilos per sq. mm.	Tens. strength lbs. per sq. in.
Aluminum pure.		.....	2.67	18.7	26,592
"	98%, copper 2%,	2.78	2.71	30.7	43,655
"	96%, " 4%,	2.90	2.77	31.1	44,234
"	94%, " 6%,	3.02	2.82	38.6	54,900
"	92%, " 8%,	3.14	2.86	35.5	50,492

These figures show that the addition of only 2% of copper increases the tensile strength of aluminum from about 27,000 to nearly 44,000 lbs. per sq. in., and the addition of 6% of copper more than doubles this tensile strength. It will be also noted that an alloy can be made having double the strength of pure aluminum that is less than one-twentieth heavier than the pure metal. As *The Engineer* remarks, experiments on so small a scale are no guarantee that an alloy of equal qualities could be made on a commercial scale, and further experiment is necessary as to the general behavior of this alloy; but it is interesting.

PERSONALS.

Mr. JOHN F. WALLACE, M. Am. Soc. C. E., has been appointed Engineer of Construction of the Illinois Central R. R.

Mr. W. B. KING, City Engineer of Waco, Tex., has accepted the position of Chief Engineer of the Fort Worth & Rio Grande Ry.

Mr. HENRY F. SAMPSON has been appointed Superintendent of the Connecticut River R. R., vice Mr. JOHN MULLIGAN, who has been made President of the road.

Mr. HOWARD MURPHY, Secretary and Treasurer of the Engineers' Club of Philadelphia, has been re-elected to that office for the present year against considerable opposition.

MR. JOHN W. ROOT, Consulting Architect of the World's Fair, died in Chicago on Jan. 15, aged 38 years. Mr. ROOT was a member of the firm of Burnham & Root, the leading architects in that city.

Mr. JAMES H. PHYFE has been appointed Assistant Superintendent of the New York Central & Hudson River R. R. between New York & Albany, including the Grand Central Station. He has held this position before.

Mr. W. W. FAGAN, Superintendent of the Kansas City, Fort Scott & Memphis R. R., has resigned, to become General Superintendent of the St. Louis, Iron Mountain & Southern and Little Rock & Fort Smith roads. He will be succeeded by Mr J. H. SULLIVAN.

Mr. S. H. H. CLARK, General Manager of the Union Pacific Ry., has established five main divisions, with the following Superintendents: ROBERT BLICKENSDERFER, Nebraska division; J. O. BRINKERHOFF, Kansas division; R. J. DUNCAN, Gulf division; W. H. BANCROFT, Mountain division; O. H. MCNEIL, Pacific division.

Mr. J. C. MOORHEAD, Superintendent of Transportation on the New York, Pennsylvania & Ohio R. R. has been appointed General Superintendent of that road and of the Chicago & Atlantic Ry. Mr. A. M. MOZIER will be Superintendent of Transportation. Mr. C. A. ALLEN will be Superintendent of the Western division and Mr. H. N. DONALDSON Superintendent of the Mahoning division.

Mr. GEO. HOLT HENSHAW, M. Can. Soc. C. E., died recently in Brooklyn, N. Y. He was born in Montreal in 1831. He was engaged for many years on the improvements on the Grand Trunk and Intercolonial railways and on the Ottawa River. For seven years, beginning in 1860 he directed the construction of many of the Danish railways. For the last two years he had been in New York and Brooklyn developing an idea to protect beach fronts from the action of the ocean. It was his purpose to have tried it this year at Manhattan and Brighton beaches.

NEW PUBLICATIONS.

—*Photographic Mosaics*, 1891. New York: EDWARD L. WILSON. 8vo., pp. 288; illustrated; paper, 50 cents; cloth, $1.

This annual, which has been edited for 27 years by Mr. WILSON, is full of useful hints for photographers, amateur and professional. Most interesting are the carefully collected notes of progress, showing the recent applications of photography to many branches of science.

—*Useful Information and Data for Railway Officials.* Compiled by T. J. NICHOLS, C. E., Superintendent of Railway Department of McElroy, Keeney & Co., real estate agents, 134 Washington St., Chicago, Ill.

A little vest pocket pamphlet of 50 pp., with tables of weights of materials, quantities of materials per mile of track, weights and measures, earthwork, contents of tanks, etc., and notes on signals and other railway matters.

—*Directory and Inspection of Eastern Lumber Centers.* Issued by the New York *Lumber Trade Journal.*

This little book of 120 pp. contains directories of lumber dealers in several cities, rules for inspection, and other matter of interest to the lumber trade.

—*Geological Survey of Missouri.* Bulletin No. 2. Bibliography of the Geology of Missouri, by F. A. SAMPSON. ARTHUR WINSLOW, State Geologist. Small 4to. pp. 176.

This good sized book is entirely occupied with the titles of books and papers relating to its subject matter, which illustrates how American technical literature is growing, which is still more definitely illustrated by the following extract from the preface:

The dates of the publications whose titles are given range from the year 1804 to the year 1890; during this interval they are distributed as follows:

Between the years	1801	and	1810	3	were	published.
"	"	1811	"	1820	7	"	"
"	"	1821	"	1830	27	"	"
"	"	1831	"	1840	33	"	"
"	"	1841	"	1850	74	"	"
"	"	1851	"	1860	126	"	"
"	"	1861	"	1870	124	"	"
"	"	1871	"	1880	204	"	"
"	"	1881	"	1890	203	"	"
Total					801		

At the beginning of this century, according to this record, the subject of the geology of Missouri attracted little public notice. It then received meager attention for a period of 40 years, and it was not until after the year 1840 that the importance of the subject became appreciated and that active interest was developed. From that time on this interest has apparently been vigorous and continuous.

SOCIETY PROCEEDINGS.

Connecticut Civil Engineers' and Surveyors' Association.—Annual meeting, held Jan. 13, at Hartford, Conn. The following officers were elected for 1891: President, E. P. Augur; Vice-Presidents, T. H. McKenzie and W. H. Burnett; Secretary and Treasurer, F. W. Whitlock, Waterbury, Conn.; Assistant Secretary, A. R. Wadsworth, of Farmington, Conn. Executive Committee, Messrs. Augur, McKenzie, Fields, Phipps and Bunce; Membership Committee, Messrs. Chandler, Davis and Smith. The retiring President, Mr. Wm. B. Palmer, delivered his address, and the remainder of the session was practically spent in discussing the draft of a proposed law concerning dams and reservoirs, submitted by Messrs. Welton, Hull and McKenzie, as a special committee appointed for the purpose. The papers especially prepared for this meeting were not read, but will be printed in the proceedings and discussed at the next meeting.

The Iowa Civil Engineers' and Surveyors' Society.—Fourth annual convention held at the City Hall, Des Moines, Iowa, Dec. 30. The President, Mr. Ed. M. Gilchrist, presided over the usual attendance of members. The President's address was delivered. The reports of the Secretary and Treasurer, Mr. Seth Dean, showed a slight increase in membership, five being declared elected at this meeting, a small balance in the treasury and a material growth in the library. The convention elected as honorary members Messrs. R. S. Finkbine and R. L. Chase, both of the Board of Public Works of Des Moines. The most notable papers read were: "The Measurement of Earthwork," by Mr. R. G. Brown, and "Taking Notes for Municipal Improvements," by Mr. Wm. Steyh. The officers elected for 1891 were: President, M. Tschirgi, Jr., of Dubuque; Vice-President, Wm. Steyh, Burlington; Secretary and Treasurer, Seth Dean, Islewood.

Western Society of Engineers.—Annual meeting held Jan. 7, at the Sherman House; President L. E. Cooley in the chair and about 200 members and guests present. Secretary Weston reported a membership of 351, as contrasted with 255 in 1889. Receipts for the year $3,299.50; expenditures, $2,870.13; balance in hand, $429.37. At this meeting 23 members were elected, and it was recommended by Mr. Weston that committees be appointed to secure more commodious quarters, and to increase the library. In his annual address President Cooley defined the relations of the engineer to the public, sketched the rise and progress of the Western Society, and the engineering events of that section occurring since the organization of the Society. A banquet followed, at which many speeches were made. Mr. E. L. Corthell spoke on the results of opening a way "From the Unsalted Seas to the Briny Deep," and pointed out the many advantages of opening a communication between the two. Other short addresses followed from Mr. Octave Chanute, Mr. William E. Worthen, Mr. Don G. Whittemore and Mr. A. M. Wellington. The following was announced as the result of the vote for officers for 1891: President, L. E. Cooley; Vice-Presidents, J. F. Wallace and W. O. Seymour; Secretary, John W. Weston; Trustee, O. Chanute. On motion of Gen Fitzsimmons, the election of Mr. Cooley was made unanimous.

Engineering Association of the South.—Monthly meeting at Nashville, Tenn., Jan. 8, 1891. Vice-President W. L. Dudley presiding and 19 members present. Six new members were elected. Mr. D. W. Cooke exhibited and explained a model and drawing of a system of light-draft towage boats proposed by him for Western rivers. This is a series or train of barges, each having one convex and one concave end. The convex bow of one was intended to be fitted into the concave stern of the next ahead, in order to do away with but one cross-section resistance in moving through the water. The line of tows was proposed to be drawn by a side wheel tug at the head of the tow, having the same cross section and having a concave stern like the other barges. Barges carrying freight to any particular point are intended to be dropped out at way points, like freight cars from a train. A paper entitled "A Study of Steam Engine Pistons" was then presented by Prof W. T. Magruder, of Vanderbilt University. The paper after going into an extensive discussion of the formation, dimensions and features of steam pistons for large engines in general, drew a comparison between the best forms in practice and the piston of the Holly Gaskill pumping engines at the Nashville water-works, which have twice broken recently. The paper showed that it was highly improbable that the breakage had been caused by the clearance being filled with condensation water. Mr. Olin H. Landreth submitted for informal discussion a draft of a highway bill which was being prepared by a committee appointed by the Nashville Commercial Club for presentation to the present State Legislature. The proposed bill comprises a State Board of Engineers, composed of three members appointed by the Governor, meeting quarterly, having chiefly advisory powers, but having the right to specify and determine the qualifications of county engineers and the forms of records and maps by which the work of the several counties shall be recorded. The bill further places the control of each county in the hands of a commission composed of three members to be appointed by the County Court, and requires the Commissioners to place the execution of all work in the hands of a competent county engineer who in turn may appoint as many district superintendent as may be essential to maintain the entire road system of the county, each superintendent being required to devote his whole time to his district, thus securing the *maintenance* of highways rather than their periodical repair. The proposed bill abolishes the civil district or township lines in the collection and expenditure of taxes, thus making the county the unit and giving each county the option to abolish the road labor system by reducing the number of days to be assessed each resident to zero if desired. The bill does not increase the road tax above that of the past few years, but in fact substantially reduces it by placing the maximum number of days' labor at eight in place of twelve days as at present.

American Society of Civil Engineers.—The annual meeting of the society will be held Jan. 21 and 22, 1891. The meeting will begin at 10 o'clock Wednesday morning, Jan. 21. The annual reports will be made; officers elected; reports of committees presented and discussed; time and place for the next convention considered; general business transacted. Lunch will be served at the Society House at 13:30, and the session resumed in the afternoon. On the evening of Wednesday the meeting will be continued. During the evening an illustrated description of the progress of the work of the Chignecto Ship Railway will be given by Mr. John F. O'Rourke, M. Am. Soc. C. E.

On Thursday, Jan. 22, members desiring to accompany the excursion will meet at the Society House at 8:30. By invitation of Mr. George B. Post, the architect, and by courtesy of Mr. Joseph Pultizer, the new *World* building will then be visited and will occupy the time until 10:15. The party will then cross the Brooklyn Bridge and proceed by special train on the Fifth Ave. line of the Brooklyn Elevated Ry. to the Flatbush Ave. Station (transportation being furnished by courtesy of Mr. C. C. Martin, M. Am. Soc. C. E., Chief Engineer and Superintendent of the Bridge, and Col. Fred. Martin, General Manager of the Elevated.) At this point the main intercepting sewer for the drainage of a large portion of the city of Brooklyn, under construction by the Anderson & Barr system of tunneling, will be inspected. At 12 o'clock a special train on the Long Island R. R. will convey the party to the Ridgewood pumping station of the Brooklyn Water-Works, where lunch will be served at 13 o'clock. By invitation of Mr. Robert Van Buren, M. Am. Soc. C. E., the new work for the water supply of the city of Brooklyn will be inspected. This comprises the new Worthington pumps, and the auxiliary driven well system, which will be explained in detail by Mr. Van Buren and his assistants. At 15 o'clock the party will return to New York by the same route, and those who desire may visit either the new terminal work of the Pennsylvania R. R. at Jersey City, by invitation of the engineers of that work, or the Hudson River tunnel at its western end, by invitation of Mr. Wm. R. Hutton, M. Am. Soc. C. E., Chief Engineer.

For those who do not care to visit the *World* Building and the sewer tunnel, an alternative excursion is provided by invitation of Mr. Theodore Voorhees, M. Am. Soc. C. E., Gen. Supt. N. Y. C. & H. R. R. R., by special train to Mott Haven, where the operation of the new pneumatic interlocking signal apparatus and the heavy masonry connected with the depression of the tracks on the other side of the Harlem River may be examined. This party will leave the Grand Central Station at 8 A. M. Those who take part in this excursion can join the main excursion at the Flatbush Ave. Station, Long Island R. R. at 12 o'clock.

In the evening a reception for gentlemen will be held the house of the society, and at 21:30 o'clock supper will be served.

FRANCIS COLLINGWOOD,
O. F. NICHOLS,
CHARLES W. HUNT, } *Committee.*

New York Railroad Club.—At the meeting on Jan. 15 two papers were read. The first paper was on "Qualities Essential for a Free Steaming Locomotive," by A. E. Mitchell, Mechanical Engineer, New York, Lake Erie & Western R.R., which was read by the Secretary. The essential points are that the boiler should be carefully designed the parts properly arranged and the firing done on correct principles. There should be sufficient heating surface and grate area to produce steam faster than the cylinders can use it. The boiler should be designed for cylinders of 1 in. greater diameter than it is intended to apply, and the diameter of the boiler should be three times that of the extra sized cylinder. Ample water space should be provided. About one-tenth of the heating surface should be in the firebox, and this should not be materially reduced for anthracite burners. The diaphragm plate in the extension front should be set so as to cause the fire to burn a little brighter at its front end, and should be adjusted for the average quality of coal used. In some cases the fire is regulated entirely by the exhaust nozzles, but this causes too uneven a draught and is hard upon the fire. The smoke stack should be larger at the top than at the bottom, as in that form it acts better as an ejector to maintain the partial vacuum (½ to ¾ lb.) in the smoke box, which is required to obtain a proper suction in the tubes. A stack should be designed which can be applied to all classes of engines, with cylinders from 17 ins. to 26 ins. diam., and if made of cast-iron, the old stacks will have a market value as scrap. The fire should not be too heavy, and coal should be applied frequently and in small quantities so as to keep a white-hot fire; when it becomes red hot it is too thick and cannot get enough air. There should be no holes or dead spots in the fire, especially with anthracite; when they do occur, live fire should be raked over them, and not green coal applied, as that would spoil the fire. With coal which forms much clinker the fire should be exceptionally thin. The grates should seldom be shaken, as with a properly kept fire the vibration will cause the ashes to fall through into the ash-pan. The engineer should keep a uniform water level in the boiler, so as to keep an approximately uniform pressure; he should have sufficient steam to start without cutting off at full stroke, as this tears large holes in the fire. The engineer and fireman should work together harmoniously.

A paper on "Car Service" was then read by W. G. Wattson, Division Superintendent, New York, West Shore & Buffalo R. R. He stated that there are over 1,000,000 freight cars on the railways of the United States; their average service is only 17 to 20 or 25 miles per day, or 2 hours' service, taking 25 miles per hour as the speed of the fast freight trains and 12 miles per hour that of the local freight trains. He considered that the average should be 40 miles per day. A leading trouble is that the railways are not prompt in moving and sending back the empty cars. With the cars under the control of car service associations, consignors have to pay $1 per day, demurrage, and he thought if railways had to pay 25 cts. per day demurrage it would lead to a great improvement. There are now only about 25 of these associations, and they cover too small a number of cars to show conclusive results. Many shippers now build their own cars and require roads to haul them or lose the business. He proposed the formation of equipment companies to acquire the freight equipment of roads in certain geographical limits, the companies to have control of distribution and repairs. Storage yards would be established at the main business centers, to which the railways would send the cars as soon as done with. The railways would pay a per diem charge, and a penalty would be imposed upon the equipment company for a failure to furnish sufficient cars for the requirements of roads within its district. In the discussion it was stated that there might be some trouble from cars included in car equipment trusts and in railway mortgage bonds covering rolling stock, but Mr. Wattson thought that the railways could use such cars for their local traffic, his plan being only intended for through interchange traffic.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

Vol. XXV. Saturday, January 17, 1891.

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GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—Next meeting, Jan. 17. Secy., Howard Murphy, 1122 Girard St.

Western Railway Club.—Next meeting, Jan. 20. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Jan. 20. Secy., S. M. Wickersham, Pittsburg, Pa.

Michigan Engineering Society.—Annual convention, Jan. 20 to 23, at Lansing. Secy., F. Hodgman, Climax.

Boston Society of Civil Engineers.—Next meeting, Jan. 21. Secy., S. E. Tinkham.

Engineers' Club of St. Louis.—Next meeting, Jan. 21. Secy., W. H. Bryan, 30 South 7th St.

American Society of Civil Engineers.—Annual meeting, Jan. 21. Secy., John Bogart, 127 E. 23d St., New York.

Ohio Institute of Mining Engineers.—Annual meeting begins Jan. 22, at Columbus. Secy., E. M. Hazeltine.

Denver Society of Civil Engineers.—Next meeting, Jan. 27. Secy., Geo. H. Angell.

Civil Engineers' Society of St. Paul.—Next meeting, Feb. 2. Secy., G. L. Wilson.

Rensselaer Polytechnic Institute Alumni.—Midwinter reunion at Kansas City, Mo., Feb. 2 and 3.

Western Society of Engineers.—Next meeting, Feb. 3. Secy., J. W. Weston, 230 La Salle St., Chicago.

Civil Engineers' Association of Kansas.—Next meeting, Feb. 4. Secy., J. C. Herring, Wichita, Kan.

Technical Society of the Pacific Coast.—Next meeting Feb. 6. Secy., O. von Geldern, 408 California St., San Francisco.

Civil Engineers' Club of Cleveland.—Next meeting, Feb. 10. Secy., A. H. Porter, 50 Euclid Ave.

New England Railroad Club.—Next meeting, Feb. 11. Secy., F. M. Curtis.

Engineering Association of the Southwest.—Next meeting, Feb. 12. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Northwestern Track and Bridge Association.—Next meeting, Feb. 13. Secy., D. W. Meeker, St. Paul, Minn.

Northwest Railroad Club.—Next meeting, Feb. 19. Secy., H. P. Robinson, St. Paul, Minn.

New York Railroad Club.—Next meeting, Feb. 19. Rooms, Gilsey House. Secy., H. G. Prout.

Engineers' Club of Cincinnati.—Next meeting, Feb. 19. Secy., J. F. Wilson.

WE have received lately several communications from abroad requesting information concerning Mr. ERNST SCHOENROCK, of San Remo, Italy. Mr. SCHOENROCK, we find, has obtained passes on English and Continental railways by virtue of a letter from this office authorizing him to act as a foreign correspondent. He has such a letter, now about two years old; but it is only just to the officers of the London, Chatham & Dover, the St. Gothard, Northeastern Railway of Switzerland, Jura & Simplon and Paris, Lyons & Mediterranean railways to state that he is in no sense "our foreign correspondent." Early in his trip abroad he furnished us some non-acceptable matter, but since then we have heard of him only as above stated. He has no authority from us to ask for the favors extended, and is not recognized as a foreign correspondent by this office.

ENGINEERS and surveyors are said to be in demand just now in Brazil, and the Brazilian Minister at Washington, the Hon. GOORTMANN WALENTE, has, by an official letter of Dec. 20, asked that the American Society of Civil Engineers bring this fact to the attention of its members, as noted in our report of the last proceedings of that society. This Minister says that "since the revolution of Nov. 15, 1889, the need of engineers and surveyors begins to be very much felt in consequence of the great development of private industries, in which all those available in the country are already engaged." Engineers seeking employment under this letter are requested to communicate with Mr. TEIXEIVA DE MACEDO, Brazilian Consul-General, No. 1 Pearl street, New York City. It will probable save patience, and postage stamps, for some of the readers of this item if they first understand that there are certain accomplishments necessary for any successful practice in South American States. In the first place some acquaintance with Portuguese, or Spanish, is essential in this case; and as we understand the letter it is engineers and surveyors of mature experience that are now needed in Brazil, and not men to fill subordinate posts. While, as a rule, citizens of the United States are well received in that country, the man going there must be ready to stand the chances of further political upheaval, and a present system of government that is very evident to those governed.

IN connection with the coming annual meeting of the American Society of Civil Engineers, and the very important nature of that meeting to all members, the official announcement of that election and the issue of ballots therefor, calls for a word of caution and explanation. First, in regard to the real meaning of the statement—"That all members of the society not in arrears are entitled to vote." While we would advise all members to pay now their dues for the year beginning Jan. 1, 1891, the Constitution says (Art. IV. Sec. 5): "Members in arrears for *more* than one year's annual dues shall not be allowed to vote until such dues are paid." The italics are ours, and we make this note, in answer to a query, to show that the member who has not, for any good reason, paid his dues for 1891, in advance, is still entitled to vote under this clause.

THE receipt of a late circular note from the Secretary of the Am. Soc. C. E., stating that "it is feared that a few of the envelopes designated 'Ballot for Officers,' may have been omitted by accident in inclosing papers for ballot," has also awakened fears among some of the members. According to enclosures sent to us there were cases in which the "special envelope" was not "omitted," but one was enclosed without the heading of "Ballot for Officers." As votes have been cast in these envelopes, the question is asked us whether or not such votes can be classed as informal. We believe not. The blunder was made at headquarters; and as these envelopes did not carry the red imprint of "ballot for membership," they could not be confused with those opened at the last meeting, and should therefore be credited to the general vote. The list of voters is always open to the inspection of members, and this list will readily settle the question of receipt of vote.

THE U. S. Senate Committee on Foreign Affairs explicitly declares the Clayton-Bulwer treaty of 1850 obsolete, by "the forms of that convention, the principles of public law or good morals," and also advocates national aid to the builders of the Nicaragua Canal. This opinion is likely to have important results if adopted by the general government. Upon the political aspect of the question we have nothing to say, as that can be safely left to the consideration of Mr. SHERMAN and his Senatorial colleagues. But from a commercial and business point of view the suggestions of the committee are very solid. In any undertaking of such enormous dimensions as the construction of an interoceanic canal, private enterprise can only secure the requisite capital by the promise of liberal interest and the payment of this interest out of principal during a long period of construction. The delays incident to such work and the too-often uncertain relation between the revenue on the completion of the canal and the final cost of the whole work, make the raising of this capital by individuals difficult and very expensive. The history of the Panama Canal is a case in point.

While the Nicaragua Canal has been started on very different lines, and has as a basis of work and estimated cost of completion a most elaborate and satisfactory survey and engineering investigation, the financial conditions are practically the same as with its ill-fated predecessor, as far as the raising of capital is concerned. While the managers of the new canal have conducted their affairs on a sound business basis and have secured the full confidence of the governments of Nicaragua and Costa Rica, they are obtaining money at 5% interest and are obligating themselves to pay this interest on the final cost of the work. As the Senate Committee shows, if the ultimate cost is figured at about $88,000,000, and the time of completion at six years, the accruing interest by that time would amount to at least 15% on the total, or about $13,000,000. And further than this, if the work is completed upon existing plans, the amount of bonds and stock outstanding would, at 5%, require an annual income of $12,500,000, and to get this a tariff would be necessary that would interfere to some considerable extent with the adoption of the new route by commerce.

These conditions would be very materially changed by a guarantee by the United States government such as is proposed in the bill now before the Senate. There would be no difficulty in raising the money at 3% instead of 5%; the work could be pushed with vigor to an early and successful end, and as a consequence of the resulting economy the tariff could be fixed at a figure that would at once turn an enormous flow of traffic into its channels. All that the government would really lend would be its powerful name; and as this is an American canal in its inception, its progress to date and in its undoubted influence on our commercial relations with the rest of the world, this is not too much to ask. While our government has not inaugurated this work and could not well do so, but has left that to private individuals, the canal is now well commenced and the United States can afford to back this private enterprise for public good in a manner that will insure its speedy and economical completion. We cannot afford to have this canal built by foreign capital and risk the consequent foreign control of an American waterway.

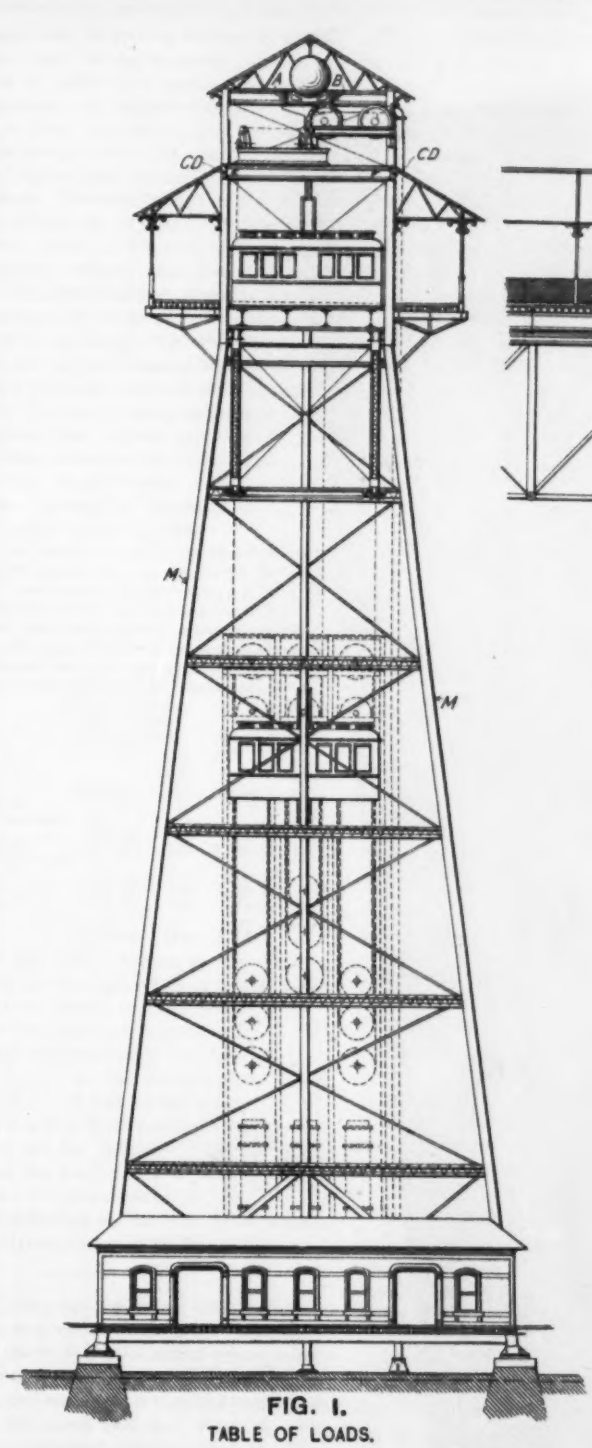


FIG. 1.

TABLE OF LOADS.

	Lbs.	
Girders A B supporting tank, resting on 4 posts, P_1, P_2, P_3, P_4, distributed	98,000	
Counter Balance sheave axles, vertical load on each	7,200	For sheave beams and girders C D, E F.
" " " horizontal thrust "	7,200	
Main sheave axles, vertical load on each	25,000	
" " horizontal thrust on each	25,000	
Main Posts M, M, M, M, strain on each post	51,000	
Posts, P_1, P_2, P_3, P_4, in ordinary operation sustain load from tank only:		
P_1 and P_4	14,666	
P_2 and P_3	29,333	
Girders M G M, M H M, G H, I K, sustain no load in ordinary operation:		
L L and N N, each pair has center load of	50,000	
Posts R R_2 and R R_3 vertical load	125,000	
R R_1 and R R_4 vertical load	63,000	
Girders O O, supporting cylinders are subject alternately to an upward pull of	132,000	
A downward thrust of	62,000	

DURING ACTION OF SAFETY DEVICES.

Posts P_1, P_2, P_3, P_4 sustain, in addition to weight of tank as above, a longitudinal strain, parallel to and 12 ins. from the axis	36,000	
Plus a horizontal concentrated force of	12 700	
These have same point of application and are treated as moving loads.		
Horizontal Girders I K, G G and H H sustain at centers a concentrated horizontal force of	12,700	

Girders supporting sheaves should have 30 per cent. allowed for impact. Maximum allowed strain in P_1, P_2, P_3, P_4, 15,000 lbs. The above loads are those of elevator machinery, and do not include the weights of the girders and posts themselves.

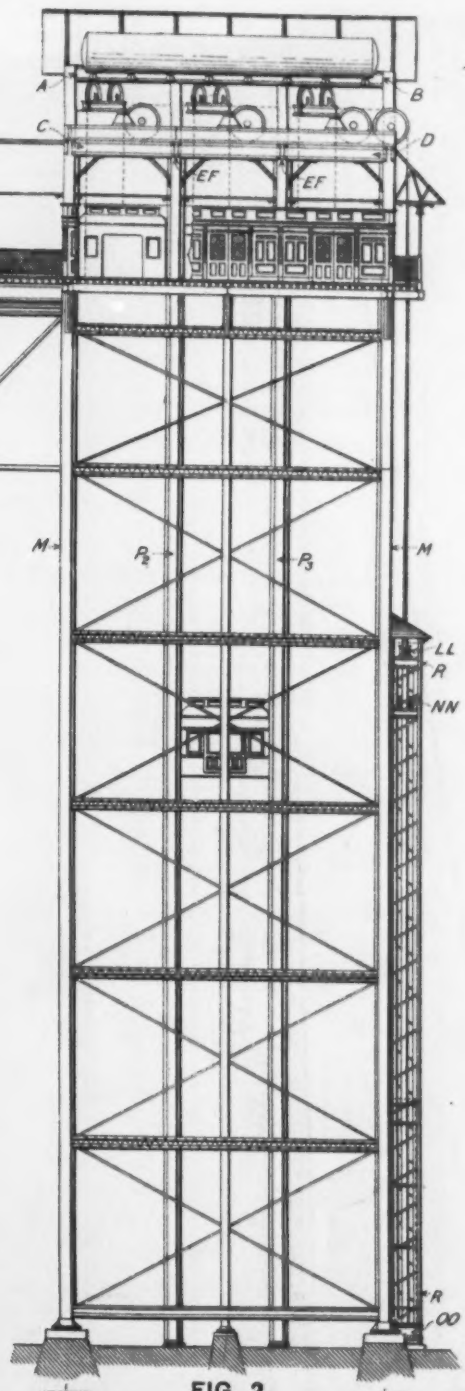


FIG. 2.

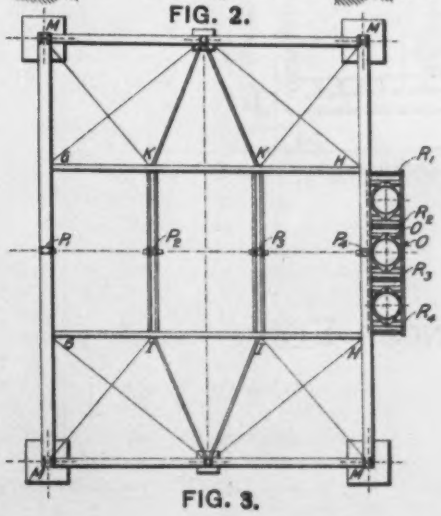
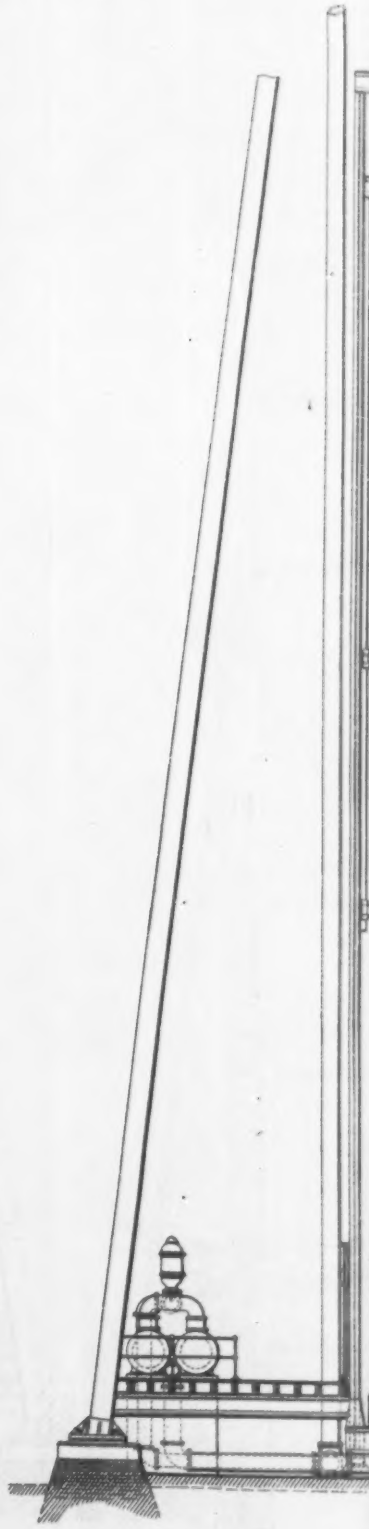


FIG. 3.



PASSENGER ELE

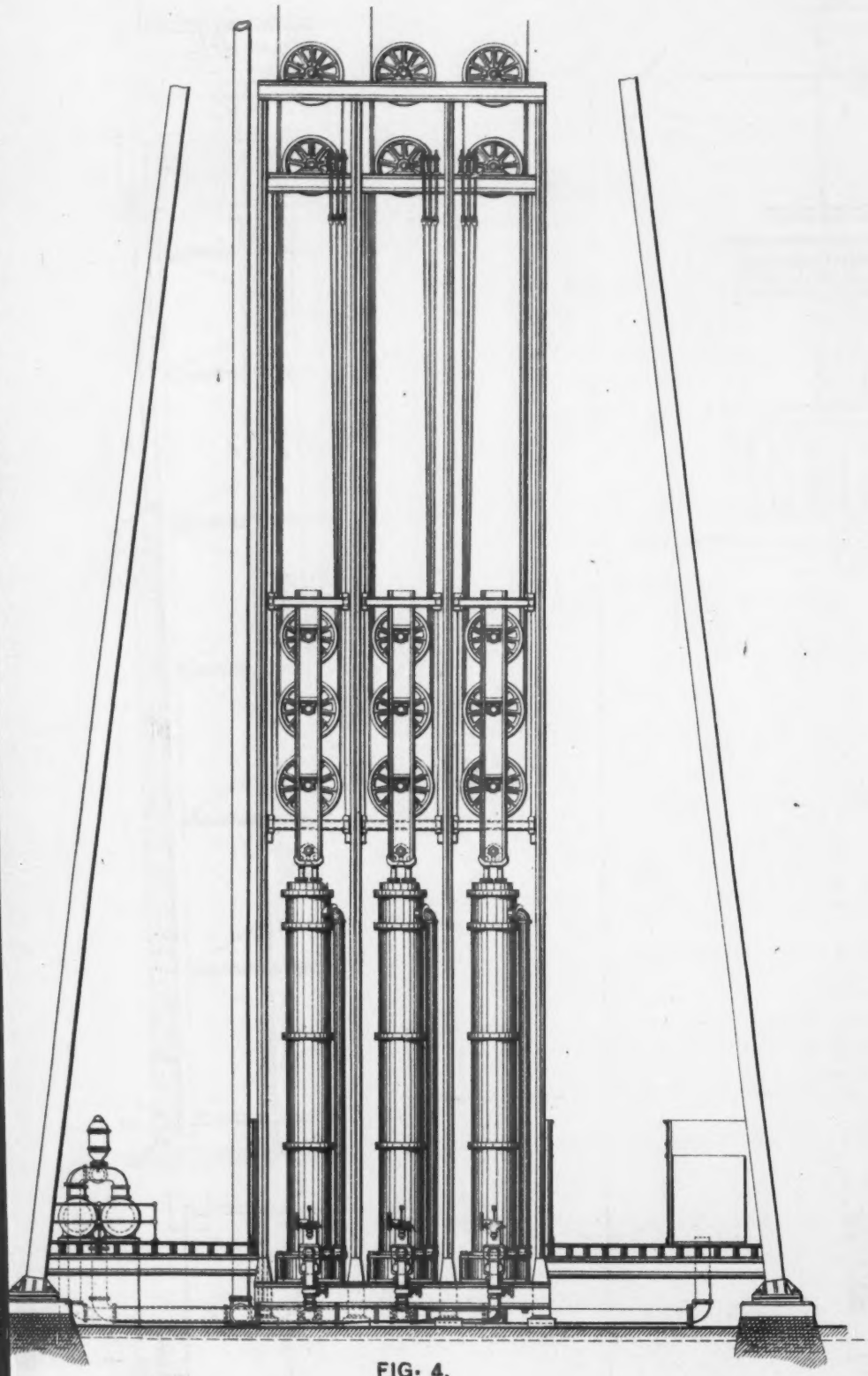


FIG. 4.

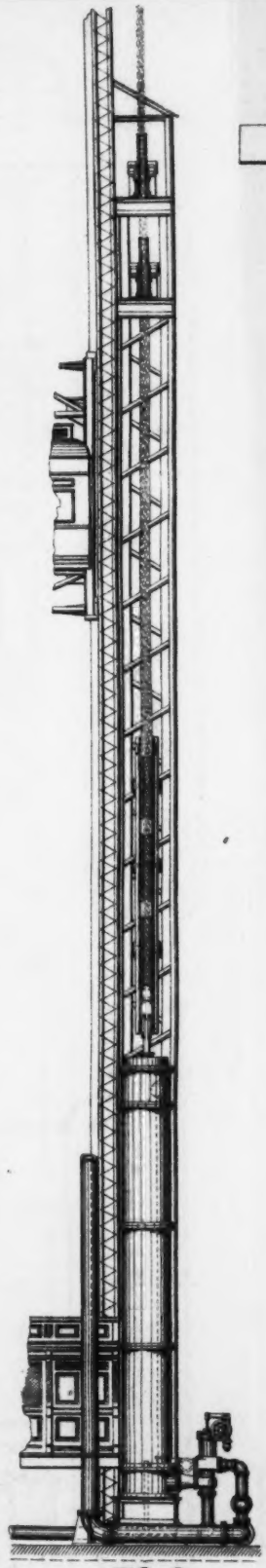


FIG. 5.

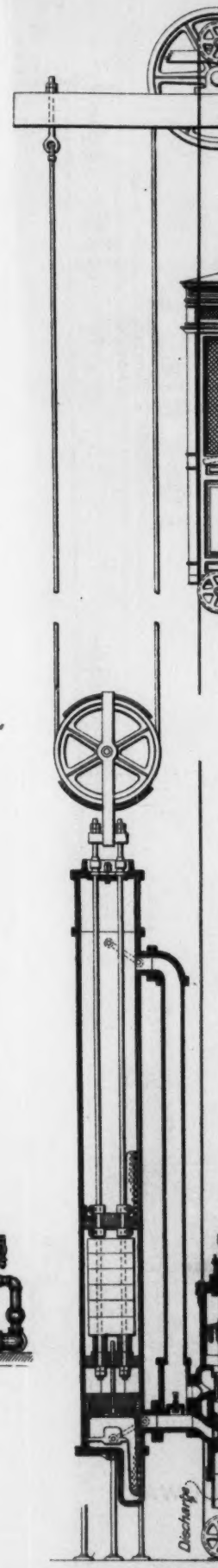


FIG. 6

Passenger Elevators for North Hudson County Railway, at Weehawken, N. J.

Otis Bros. & Co., Builders.

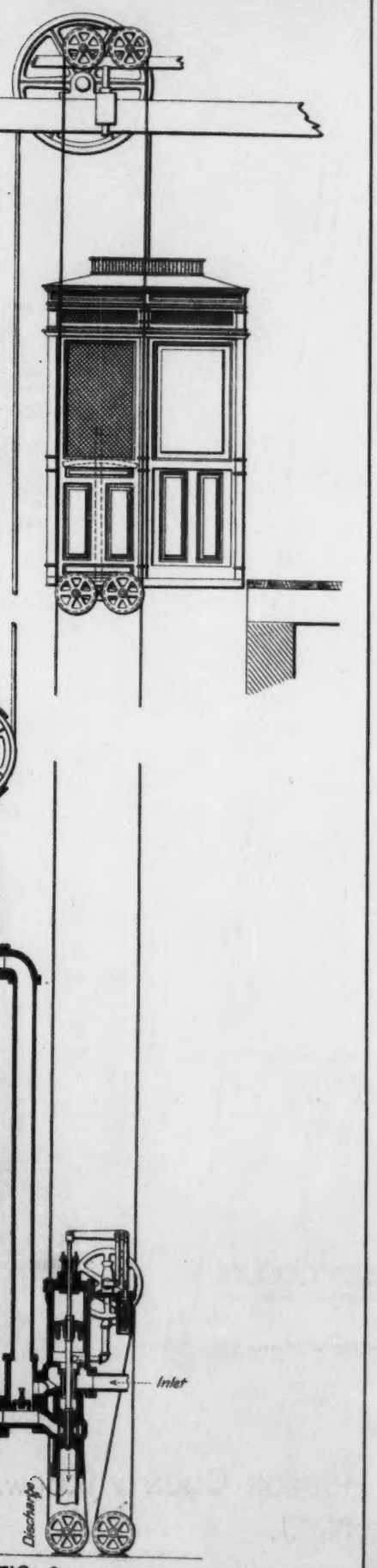


FIG. 6.

CHAS. HART & SONS, LITH., 95 VESEY ST., N.Y.

THE *Railway News*, in two recent issues, makes an effort, which may fairly be called absurd, to disprove what it calls "the grotesque charge" against the managers of English railways "of expending 67½, or even the odd 7½ per cent. more than American companies in the conduct of their undertakings," by which it means management of transportation. The fact being as well proved as any statistical fact can be that freight transportation, at least, costs in England several times what it does in this country, the wise course for the defender of English railway practice is to admit the fact and explain it away by showing why the difference is necessary, for which a goodly string of just and unjust reasons may be given. But, following a tendency which is often conspicuous in English journals, to deny and conceal such differences rather than expose and complain of them, the *Railway News* does not take this course. Instead, it prints the following table, which it declares to be "absolutely destructive" of the "grotesque charge" above quoted.

We know of no better all-round test, under these circumstances [less traffic per mile on the Great Western], than that of the "train mile," and the following table exhibits the difference between the working cost of the two railways founded upon the number of miles run by trains. In every item the Great Western Co. makes a most favorable comparison, the cost per train mile of the New York Central Co. being higher in the total by 69 per cent.:

	Great Western, year ending Dec. 31, 1889.		N. Y. Central, year ending June 30, 1889.	
Expenditure.	Amount. £	Per train mile. d.	Amount. £	Per train mile. d.
Maintenance of way and works	876,816	6.36	823,592	9.03
Locomotive power	1,091,423	7.93	1,289,626	14.14
Maintenance of car and wagons	370,330	2.69	444,539	4.88
Traffic expenses	1,196,506	8.69	1,569,682	17.21
General expenses	658,034	4.78	573,283	6.29
Total	4,193,109	30.45	4,700,727	51.55

Now, in the first place, wages in this country are very nearly double, and prices of railway material fully a third higher in this country, factors which the railway manager cannot control, and hence which no rational being who is discusssing the question to get at the facts rather than to make out a case will fail to allow for. On this account alone the New York Central cost per train mile compares on an equality with the Great Western, to say the least, and it will be noted that the percentage of maintenance of way cost per train mile is slightly less on the New York Central, as it should be from its denser traffic.

BUT then comes up the more vital question: What do these respective "train miles" represent? The *News* has the New York Central report before it, or claims to have; and by a little figuring, and by making the one assumption that the haulage on way freight is the same east and west, it could readily have determined from it that the New York Central "train mile" represented in 1889 the haulage of the following tons of load:

Freight trains.	Eastbound. Tons per train.	Westbound. Tons per train.	Tons. Av. per train.	Av. haul, miles.
Through freight	129	33	83	440
Way freight	2.5	103	104	14½
Total per train	354	136	246	187

Passenger trains, 51 passengers, hauled 29 miles, 5 cars weighing about 130 tons.

Now, what does a Great Western train represent? There are no means for determining exactly, for English railway returns do not include ton miles or passenger miles; but the *Railway News* figures out with some care that the Great Western's average freight rate on all freight is 0.8d. (1.6 cts.) per ton mile. If so, it is greatly below the English average, but we will assume this. It also gives 53½ per cent. as the expense ratio, which makes the cost per ton mile 0.43d. (0.86 ct.), and dividing this into the cost per train mile we obtain *just 71 tons* (!) as the average Great Western freight train load. Similarly, the average English passenger rate is somewhat over 1d. (2 cts.) per mile, whence we find the average passenger train load to be 28 to 30 at most. "It appears, therefore, that," in the eyes of the *Railway News*, "there is not the slightest foundation for the charges of extravagant working against the railway management of England," when it takes there somewhat more of labor and material to haul trains carrying 30 passengers and 71 tons of freight than it does here to haul 51 passengers and 187 tons of freight! And this, without making any allowance for the frightful disproportion in direction of traffic on the New York Central, which obliges the trains to run almost empty one way, for which there is no parallel in England, and except for which the average New York Central train would be nearly twice as heavy as it is now!

Truly, there are none so blind as those who will not see.

A REMARKABLE instance of skepticism concerning the merits of those "new fangled" railway appliances, the automatic coupler and the automatic air brake, comes to us in the form of questions from the manager of a short (80-mile) railway in the far West. But while the road is short, our records show it to be through a mountainous country, with 99-ft. grades and 18° curves, which would seem to imply somewhat special need for the best brakes and couplers. Nevertheless, the writer asks (1) whether it is a fact that the use of automatic couplers really reduces accidents and injuries to persons, or contributes to security in operating. With regard to brakes he queries:

(2) Is it not a fact that some of the most appalling and destructive railway accidents have resulted from reliance on automatic brakes which failed at the moment when they were most needed? Also have the cost of operating and maintaining the road and the accidents and injuries to persons been less than they would have been had reliance been placed on well disciplined brakemen?

To show that he is an honest seeker after truth he adds that if he were located where information could be had, he would like to investigate these questions until bottom was reached. He gives the superfluous information that he is not a reader of ENGINEERING NEWS, for we trust that there are few or no readers of this journal who have not found in its columns the information for which our correspondent asks, so far as it can be obtained.

IN answer to his first query it must be admitted that the proportion of freight cars now equipped with automatic couplers is too small to show any decrease in injuries and fatalities to trainmen from their use. In fact these have probably been increased, since it is more dangerous to couple the common drawhead to an M. C. B. automatic coupler than to another drawhead using the link. The benefit in saving life and limb by the use of the M. C. B. couplers will hardly be apparent until the change is substantially complete; but that a great saving of life and limb will then occur seems patent to any one who will undertake the task of coupling up two trains with the two styles of coupling, or will even watch the operation. Statistics show enormous fatalities and injuries to those engaged in coupling freight cars, while accidents in working the automatic coupling on passenger cars are practically unknown. To be sure, passenger cars are switched about much less, but still the actual process of switching is the same for them as for freight cars.

The second query of our correspondent is indeed a surprising one to be asked in A. D. 1891. If one judges the air brake by its failures reported in the newspapers, he may conclude that it is at times an unreliable appliance; but if he investigates the real state of affairs, he will find a woful tendency on the part of trainmen to lay the blame for accidents due to their own carelessness upon the air brake. Again, there have been accidents not a few, which were said to be due to "failure of the air brake" which were due really to the weak and inefficient manner in which the brake gear had been put on, or to entire neglect to give it ordinary care. If these causes of possible failure are removed, by expending a small part of the energy in disciplining car inspectors and brake repairers which our correspondent proposes to spend in disciplining hand brakemen, the brakes will not fail him in time of need. As to the comparison proposed between these "disciplined hand brakemen" and the air brake, a hundred replies might be made. Our space permits but one. Is it not strange that if the air brake costs more and destroys more than it saves, and causes more accidents than it prevents, some enterprising and discerning railway manager, familiar with every detail of railway affairs, has not discarded it long ago for passenger service and gone back to the good old hand brake?

The Electric Motor for Passenger Railways.

There are not a few ardent believers in the future of electricity who expect to see the electric motor displace the steam locomotive for general railway traffic at no distant day. Able papers on this topic were presented before the National societies of civil, mechanical, and electrical engineers last summer, and excited great general interest and discussion. Reports have been circulated from time to time that this or that new railway enterprise would adopt electricity as its motive power, but so far the schemes have all come to naught. The electrical companies have thus far been busy enough in displacing the suffering street car horse, and the noisy puffing "dummy engine" on city and suburban railways, and have taken little pains to push the electric motor into service as a rival to the steam locomotive.

But there is a limit to the building of electric railways for city traffic; and sooner or later the feasibility of electric traction for ordinary railways from a financial point of view is likely to be investigated and determined by the companies whose chances for profits are at stake. We say from a financial point of view, because that is really the question at issue. To build and operate an electric railway for a general traffic business, is a perfectly practicable scheme to-day—practicable not only from a mechanical point of view, but financially practicable as well, in the sense that the expense of installation and operation would be certainly small enough to leave at least a possibility of commercial profit.

But in order that the electric motor may come into the field to compete with the steam locomotive, it must make a better showing than this. It must be able to carry on the traffic, first and last, with no more expense than the steam locomotive, or it must show other benefits sufficient in amount to compensate the owners of the road for the extra expense. As already stated, not a few papers have been written on this topic; but the estimates of the believers in the electric motor and those who doubted its capabilities from an economic standpoint have varied between wide limits. In fact the figures thus far presented have been so conflicting as to make unprejudiced people doubt whether very close estimates can be made where accurate data are so meager and the field is to a large extent an untried one.

There are, however, certain general principles which have been found to apply thus far in all use of electricity as a motive power; and by a study of these a very fair conclusion can be reached as to the possibilities of electricity in regular railway service. The most important of these is that the smaller the units in which the power is to be used, the greater is the advantage of electricity, other things being equal. The general public is prone to forget in dealing with electricity that the electric motor is not a prime mover like the steam engine, gas engine, turbine, etc. Until we find the secret of a commercial production of electricity from heat,

the electric motor will remain merely a means of transmitting power and not a prime mover. It performs a similar office to a set of pulleys with ropes or belts or to a system of power distribution by water or compressed air, although it is more flexible and of wider adaptation than any of these.

Now for a multitude of reasons, a large prime mover (within certain limits) is in a great many ways more economical than a small one. An engine of 1,000 HP. can drive a dynamo generating electricity to drive 100 motors of 1 to 50 HP. scattered in various places and do it, if the proper conditions are present, much cheaper than the same power could be furnished by a number of independent steam engines. But if, instead of a distribution of 1,000 HP. in 100 places, we have the same amount of power distributed to only five different motors, each of 200 HP., the gain in economy over separate steam engines might almost or quite disappear.

Common experience is the best illustration of the principle. The electric motor is a formidable competitor of the gas engine, the hot air engine, and the small steam engine; but it has not displaced the large size steam engines anywhere. On the contrary, the building of larger engines has been greatly stimulated by the demands for electric light and electric power central stations. So also with electric railways. For street traffic, where electric motors of 10 to 50 HP. are sufficient to propel the cars, they have come into extensive use. But to replace the steam locomotive, generating 100 to 800 HP., the possible margin of economy is so much less that no one has so far ventured to try the electric motor in ordinary railway service.

Let us now consider a second principle of the electrical transmission of power, namely, that in any installation the relation of the cost of the copper mains to that of the whole plant varies with the distance carried, and the amount of power distributed. The first of these statements hardly needs proof. Of course it costs more to transmit electricity ten miles than one. As for the second it follows from the fact that, while an electric motor of 100 HP., for instance, does not cost ten times as much as ten 10 HP. motors, the wire circuit for transmission costs in proportion to the power to be transmitted.

Comparing, therefore, an electric street railway with an electric trunk line railway we see that the latter will have to transmit its power over far greater distances than the former, and will require perhaps 5,000 HP. on a 20-mile section, whereas the street road may never use more than 800 HP. Thus the expense of the copper mains becomes an enormous item in the case of the trunk line railway.

In the present condition of electrical science then, the roads on which electricity promises better economy than the locomotive are the roads which have a concentrated traffic requiring a moderate amount of power, which includes in fact just the roads on which it is now in use.

But in the above discussion we have proceeded on the assumption that economy in power alone was to determine the question. While this is true as regards freight traffic it is not true as regards passenger traffic. Freight can as well be hauled by locomotives burning the cheapest grade of coal as by electric motors. But for passenger service, to do away with the smoke, gas, cinders, noise, heat and jerking motion of the locomotive would be a great advantage. If, then, we can reduce the amount of power required to operate a road whose traffic is chiefly passenger, we increase by so much the chances of electricity for handling it. A great gain in this direction can be made by substituting a motor attached to each car for a locomotive at the head, thus doing away with the dead weight of the locomotive and tender.

To avoid putting the cars out of service while the motor is undergoing repairs, the trucks and bodies could be made interchangeable and enough extra trucks could be provided to keep the full complement of motor cars in service. On the other hand it would not be necessary or desirable to equip all the passenger rolling stock with motors. Only enough cars need be equipped to provide sufficient power to operate the road, and the remainder, including the rolling stock used for an extra rush of traffic, could be run as trailing cars.

It may be noted here that no such saving could be made in freight traffic, for if the motor were attached to the car it would necessarily be out of service while the car was being loaded or unloaded. The average freight car runs only 10,000 to 15,000 miles per year, and the electric motor would have to make a much greater mileage than this to be economical.

Still another well-nigh insurmountable difficulty in operating freight traffic by electricity is the switching of cars. This would have to be done by independent storage battery motors, or steam locomotives at terminals and important yards, but what to do with all the minor stations, where the necessary switching is now done by the engines of local freight trains, would be a difficult problem. The fact that there are 4,016 switching locomotives in the United States to 15,140 freight locomotives, shows that this matter of handling cars about yards and on sidings is not to be lightly passed over by the believers in electric traction for all classes of service. In passenger service, however, switching is almost entirely confined to terminals, and even there its volume is nothing compared with the "drilling" of freight cars.

Another great advantage of electricity in passenger service, when applied by separate motors on the cars is that it admits of running frequent short trains during the hours of the day when traffic is light, and increasing capacity in the rush hours by adding more cars, up to any desired number, for since each car carries its own motor, the length of the train could be unlimited. This is not alone a gain to the public, but a gain to the owner of the road; for all such added conveniences stimulate traffic, and increase receipts.

Finally, it seems to be fairly well proven that by the use of electric motors a considerably higher rate of speed can be obtained than is practicable, or safe with the steam locomotive. It is not unlikely that this consideration alone may ultimately cause the building of many electric passenger railways. With higher speed and the accompanying shortening of journeys, the weight of the cars and the dead weight per passenger can probably be somewhat reduced, thus decreasing further the required power and making the case still more hopeful for electricity.

In various ways, moreover, the cost of installation and operation may be reduced beyond what ordinary estimates would show to bring the electric passenger railway within the bounds of practicability. The use of cheap fuel, the utilization of water power and possible reductions in the cost of the copper wire by the use of very high voltage would all be important steps in this direction.

It may, then, be fairly concluded that an electric railway, built and operated primarily for passenger traffic in a location where the advantages it offers will be appreciated, has much to commend it to the favorable notice of engineers and investors. Such locations exist in the vicinity of many of our larger cities, and between some of those which lie nearest each other. Between New York and Philadelphia, for instance, a railway which would dispatch through express trains every hour or half hour, making the run in 80 minutes, with all the gain in comfort which an electric railway makes possible, would have at least a fighting chance of financial success.

Some such experiment will doubtless be tried, sooner or later. It will behoove the electrical companies when it is tried to see that it is carried out with the best available skill and experience, for its success or failure would have great influence on the fortunes of all similar enterprises.

Concerning an Open Letter.

In the present controversy between members of the American Society of Civil Engineers, we have purposely abstained from republishing any of the many circulars issued to members. They were already in the hands of the voting members, and we did not believe it would be wise or charitable to give wider publicity to many of the hasty and unguarded statements made on both sides of the question. We more than once have felt that there was occasion for the candidates to cry out, "Good Lord, deliver us from our friends." Owing to its very personal character, Mr. STOWELL'S letter is made an exception to the above rule, and we answer it for ourselves alone, having no authority to speak for the writers of the circular referred to.

In the first place, Mr. STOWELL and some other members of the society do us entirely too much honor in connecting the work of the late nominating committee with our previous or present action as editors of a technical journal. The statement made in one of the numerous circulars that this committee "was virtually packed to secure selfish ends" is unworthy a member of the American Society. The chairman of that committee was an honored past-President, and the majority, at least, were men taking a foremost rank among American engineers, and of the highest personal character and integrity. No matter what agencies might have been at work for or against any candidate, members of the society know that these men were not likely to be moved to any action opposed to their own good sense, or honest conviction of what was for the greatest benefit of the whole society. Any charge to the contrary is an insult to the committee and to those members of the society who elected them to perform a certain duty.

As editors of a technical journal, however, we have taken a decided stand in the direction of certain reforms for a long time past. We believed in "a better administration of society affairs" and fervently hoped to see the society attain to "a higher plane of prosperity and influence." But we also realized that before the commencement of this end could be reached some such vigorous shaking up as the society is now experiencing was necessary to impress upon many of the membership the importance of any action whatever. This is the first serious row in the corporate history of the American Society, and while some mud is coming to the surface as the natural result of the agitation, we are convinced that the general and final result will be permanent good, regardless of the differences of individuals or the fate of immediate candidates. At the risk of finding ourselves arrayed against personal friends, we have done our part in promoting the present eruption, and find our reward already in certain signs of a more or less permanent and healthy reaction.

Returning to our correspondent's letter, we would say, in regard to Mr. TRAUTWINE'S eligibility as a candidate, that we believe we have answered this criticism fully in previous editorials and in the published opinions of unprejudiced parties. In the present very much mixed condition of the constitution of the society, we do not think it presumptuous to say that men versed in corporate law are much more likely to interpret that document correctly than either Mr. STOWELL or ourselves, and it was because we felt uncertain as to our ability to fairly handle its shaky anatomy that we called in professional aid.

As to the second and third objections, we would say that executive ability of the kind most needed in this office is not derived from an acquaintance with members, nor is it necessarily picked up in the widest engineering practice. It is a quality outside of either experience; and, in this connec-

tion, it might be said that the detail of the office is not so intricate as some of the circulars issued would have it appear, otherwise the present Secretary, with his multitude of outside engagements, must truly be a phenomenal man. Other things being equal, an acquaintance with members is desirable; but this is a detail that an active man will soon supply for himself if his other work is acceptable to the membership. As to the broad field of engineering knowledge and literature, we believe that Mr. TRAUTWINE is much better informed than many who stand as full members on the roll of the society.

We admit that the idea of the secretary devoting his whole time to the society is "something new" in its history and that there is no such provision in the constitution. But times have changed since that ancient document was framed, and the duties of the office have grown. Had this provision been originally inserted, the society would yet be having the whole time of the present secretary and there would have been no cause for the present "revolution." Along with other members we believe that the changed conditions and a proper performance of the duties of the office demand all the time of a very active man; and further that the business of the society does suffer in consequence of the time of its present secretary being devoted to other affairs, even in part. The best evidence of this lies in the contrast by results of his own most excellent work, in past years, with that portion of work that he can now devote to society matters. He was a man eminently qualified for the post he held, and we honestly and perhaps selfishly regret that the future of the society failed to bound his ambition.

Times have also changed to the extent that the American Society of Civil Engineers is now passing through a critical period of its existence as a national society. It will need all the time of a very lively Secretary, backed by a very energetic board of direction and the hearty support of the full membership, to successfully counteract elements that are everywhere at work tending to localize engineering meetings and interests, and inevitably in time to weaken if not destroy the prestige and influence of the parent society. There is no use in shutting our eyes to a fact too well known now. We are not promoting a "trades union," as one member charges, and are heartily in favor of raising, not lowering, the standard of full membership. But we do want to see the parent association made so attractive, in the best sense of the word, so excellent in work performed and so generally respected, that all engineers worthy of the name will find it to be a sufficient honor to be members thereof and to contribute to the society and share with their fellow-members the best of their talent and experience. The society can only fill its full mission by the excellent character of the work done by those already within its ranks; the other good men will come, later but surely. This is the future we hope for, along with every well-wisher of the society, but we find the road leading in that direction to some extent blocked by a certain mutual-admiration-society tendency that would prefer quiet and practically ignoble ease to a live and useful existence.

It is now for the entire membership to decide how much of the Secretary's time should be devoted to securing the end, roughly outlined above. It is not a matter for the Secretary to decide for himself, for if the choice be given him it is only human that he should accept a lucrative outside practice when it comes to him. And once in this office he need not "seek it;" it will come to him unsought, by virtue of his position and prominence in engineering circles. We have long held and expressed the opinion that the Secretary of this society should not practice as a civil engineer, and should devote his whole time to its rapidly growing interests; and it is because of this opinion that we have made our choice between two exceptionally good candidates, one of whom is pledged to give the society his *whole time*, and the other only pledged not *to seek* outside service.

The question of salary is one to be answered by results. An inefficient man is dear at any price, and the society may also pay too dearly for that portion of any man's time—be he ever so worthy—that he can spare from the temptation of individual profit. The man who proves his fitness by "work done" will doubtless obtain from the society a fitting reward for his services.

The next objection of our correspondent is based upon what we also think is a most unfortunate choice of words in the writers of the St. Louis circular. But in justice to them it is proper to point out that Mr. STOWELL does not quote this objectionable clause either in sequence or in full, as any member can note by comparing his letter with the original circular. Knowing as we all do the member whose actions are criticised, and the men who make the criticism, there is only one reading possible for the membership, and that is that the methods of other societies are not sufficiently followed out in so itemizing a general financial statement that every detail and class of society expenditure can be easily followed out by those most interested. We believe that the fault found was one of methods and not of men, and that no member can misinterpret it; the danger that others should mistake the real meaning of similar unguarded expressions is one of the best of reasons for keeping these circulars out of the hands of the general public.

To another "open letter," which quotes very liberally from this journal, we can only make answer that if the quotations from us are read in connection with the matter not quoted, we are perfectly willing to abide by the results. We fully appreciate the interest taken in society affairs by the writer, and testify to his faithful services and hard work in years past, as fully set forth in his circular. But we also can well see that as he views our past efforts, these efforts must seem indeed revolutionary. The only trouble is that he does not read us correctly, and in the "revolutionary programme" set forth his preliminary definition of our meaning is in every case just the reverse of the convictions and expressions of the editors of this journal. We, however, most heartily agree with him in his final sentiment.

CORRESPONDENCE.

Cement Tests.

UNIVERSITY OF THE STATE OF MISSOURI,
COLUMBIA, Mo., Jan. 9, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have found in making tests of cements, where the quality was in dispute, that the strength as determined by different tests under exactly the same conditions varied about 25%, resulting from different methods of putting the best cement mortar in the molds. In each case the same amount of water was used, making the cement of the consistency of moist, crumbled earth and one was put in the mold and pressed in with the fingers and trowel and the other heavily rammed in. I have since made numerous experiments which verified the above results.

In regard to the form of clip, I have used an Olsen machine with a 2 sq. in. cross section with clip of the usual pattern, and find about 2 or 3% break in the jaws, and these are mostly caused by air holes.

HIRAM PHILLIPS.

Improved Appliances for Cement Testing.

NEW YORK, Jan. 7, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Jan. 3 I notice a communication from Mr. S. BENT RUSSELL, C. E., in which he refers to a cement clip that is in use on the Riehle cement testing machine in the laboratory of the St. Louis Water-Works Extension.

I devised the clip to hang on a pivot (the same as used in part by Mr. RUSSELL) about ten years ago, applying it to a machine we made for Mr. ROBT. VAN BUREN, Chief Engineer of the Department of City Works of the city of Brooklyn.

For the purpose of overcoming the objection made to the old form, viz., hanging the clip to the machine by means of links, I adopted the pivot bearing, and after due trial by Mr. VAN BUREN, it was pronounced a success, and Messrs. Riehle Bros. have used it ever since on all machines furnished by them. I found, however, that I had not yet succeeded in making a clip so that the pull would be absolutely straight if operators were at all careless in placing the briquettes in the clips, so I conceived the idea of covering a steel pin with rubber, or any yielding material, the pin to be made so as to conform to the curve of the clip, prescribed by General GILLMORE'S Committee of the American Society of Civil Engineers, which covering would serve a double purpose; first, allowing the briquette to center itself to the line of the pull of the machine, and, secondly, preventing the edges of the clip from cutting into the briquette, which on "short time tests" appears to me to be unjust to the briquette.

I always believed that if the pull upon the briquette were perfectly true the test would be correct, and that some device should be used to prevent the briquette being pulled "out of line." At the same time the edges of the clip should be covered with some yielding material to prevent injury to the briquette when under tension from the machine. I know that a number of devices have been presented to accomplish this, but they all require too much time to adjust the briquettes to the machine.

Cement testing on work in process of construction must be done rapidly This differs, of course, from experimental work. For example, when General STONE was building the pedestal for the Statue of Liberty he would make accurate tests at the rate of two per minute. This shows how fast the work can be done, and done correctly, and that no device should be used requiring too much time to place the briquettes in the machine. I trust that the form of clip that I have designed, and which has been used successfully, may overcome the serious objections that have been made to the standard clip.

I hope that the jig used by Mr. RUSSELL will receive due consideration, as it appears to me to overcome the great difficulty that exists in the proper mixing of cement for the moulds. Imperfect mixing of cement is the cause of a great deal of the trouble in making perfect briquettes; and from the success that Mr. RUSSELL has had with his jig it seems that the idea is worthy of attention; for if the cement is thoroughly mixed it can be placed in the moulds without having to resort to any more force than is necessary to thoroughly fill the moulds.

Very respectfully,

W. R. COCK.

[An illustration and description of the clip designed by Mr. COCK was published in our issue of Dec. 20.—ED. ENG. NEWS.]

Progress on the Busk Tunnel, Colorado.

COLORADO SPRINGS, Colo., Jan. 3, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have sent you no information in regard to the Busk tunnel lately, and will improve this opportunity to post you in progress to date as follows:

The work has been moving somewhat slowly up to the present time, but we hope we are now in shape to make a better showing. The Ingersoll people have fulfilled their part of the contract in furnishing and setting up all of the machinery required on the work, and if we can judge from the smooth and satisfactory running of it, the machinery is in every way first class. The plant at the Busk end of the tunnel consists of 3 boilers of 80 HP. each, 2 Ingersoll-Sergeant improved compressors with 20 × 24-in. cylinders, one 100-HP. engine to run the electric light dynamo, one Ball dynamo that runs both arc and incandescent lamps on the same circuit, and capable of running about 140 16 candle power incandescent lamps, one air reservoir 8 × 12 ft., and nine Ingersoll drills with tripods, columns, etc. At the Ivanhoe end of the tunnel the plant is the same, except the three boilers are 100 HP. each, and there is added a No. 7 Cameron pump to handle the water in the tunnel. The machinery cost, when set up ready for use, between $60,000 and $70,000. Below is a statement of progress by months at the Busk end of the tunnel from Sept. 16 to Dec. 31, showing total number of feet of heading driven during each month, average daily progress for total number of days in each month, and average daily progress for number of days actually worked, and a similar statement following of progress at the Ivanhoe end:

BUSK END OF TUNNEL (HAND LABOR).

Lineal feet of heading driven during 16 days in September	50
Average daily progress for 15 days actually worked	3.33 ft.
Lineal feet of heading driven during October	116
Average daily progress for 27 days actually worked	4.3 ft.

BUSK END (MACHINES STARTED NOV. 5).

Lineal feet of heading driven during November	187
Average daily progress for 29 days worked	6.45 ft.
Lineal feet of heading driven during September	191
Average daily progress for 26 days worked	7.35 ft.
Total heading driven to date	544 ft.
Total bench driven to date	444 ft.

IVANHOE END OF TUNNEL (HAND LABOR).

Lineal feet of heading driven during October.....	80
Average daily progress for 21 days worked.....	3.81 ft.
Lineal feet of heading driven during November..	117
Average daily progress fer 29 days worked.....	4.03 ft.
Lineal feet of heading driven during December..	96
Average daily progress for 20 days worked	4.8 ft.
Total heading driven to date.....	193 ft.
Total bench driven to date.....	205 ft.
Total heading driven at both ends of tunnel.....	837 ft.
Total bench driven at both ends of tunnel.....	649 ft.

The machinery was not set up and ready to run at the Ivanhoe end of the tunnel until Dec. 21, and from that time until the 1st of this month no work was done in the heading. Everything is running smoothly now at both ends, and we hope January will be a successful month with us.

The material we are driving through is a hard grey granite that sometimes changes into a substance closely resembling Leadville grey porphyry. It is so cut up by seams and small veins of decomposed granite or talc at the east, or Busk end of the tunnel as to render it necessary to timber the entire section of tunnel excavated to the present time. At the Ivanhoe end of the tunnel we have timbered 130 ft. out of the 293 ft excavated. We have had three accidents at the tunnel which resulted in loss of life; two men killed by a premature explosion of giant powder, and one boy crushed to death at the dump by runaway cars. Very truly yours,

B. H. BRYANT, Chief Engineer.

[This Busk tunnel is on the Colorado Midland Ry. and pierces the Saguache Mt. of the continental divide, between the points named. The total length will be 9,400 ft. The tunnel section is 15 × 21 ft. Work was commenced on the approaches on Aug. 1, 1890. This tunnel will save 530 ft. of elevation, 7 miles in distance and 2% of curvature.—ED. ENG. NEWS.]

San Diego Sewerage.

SAN DIEGO, Cal., Jan. 6, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of Oct. 25, to which my attention has only recently been called, owing to protracted absence from home, are two communications published at the request of GEO. E. WARING, Jr., concerning the San Diego sewerage system, one from S. T. GOLDTHWAIT, Superintendent of Sewers, and the other from DOUGLASS GUNN, Mayor. In requesting the NEWS to publish these letters Colonel WARING refers to my communication in the NEWS of March 22. The letters seem to be a triumphant refutation of my criticism of the system, although Colonel WARING does not attempt to answer it in detail or undertake the defense of the bad engineering I had pointed out. I have never written a word about the sewerage of San Diego that was not strictly true and susceptible of proof, and although as a loyal citizen of San Diego I should much prefer to hide and cover up the defects of our system as our worthy Mayor seeks to do, and point to it with pride, rather than to expose its weaknesses, I do not enjoy being placed in the false light which the publication of these letters throws upon me.

The inference to be drawn from Mr. GOLDTHWAIT'S letter is that the system is as near perfection as could be desired. But there is a strange contrast between this letter and his daily reports to the Board of Public Works, a compilation of which would tell a story that Colonel WARING would not enjoy having published to the world.

Saying nothing for the present of the tidal reservoir and the "automatic" outlet, which I have sufficiently ventilated heretofore, nor of that portion of the sewerage south of N St. having an independent outlet—two features of the system that cost about 20% of the whole, and have been *entirely abandoned*—the fact is that nearly all of the flushing tanks are absolutely worthless, and do not flush automatically. A few of them can be made to flush by tinkering with them long enough and turning on a stream that will consume from 500 to 3,000 galls. before flushing takes place. These tanks hold 150 galls. each, and are supposed to flush as soon as they fill; but the siphons of cast iron have become corroded and choked, and are so shaped and so bedded in brick masonry that they cannot be cleaned, and the whole tank is rendered useless. Take away the automatic flushing feature from the Waring system and what is there left? Nothing of which he can feel very proud, surely. Now these facts have been reported to his superiors by Mr. GOLDTHWAIT, and are matters of public record. Why he should choose to stultify himself by writing to Col. WARING that "the whole system has worked to the entire satisfaction of our community," when his daily duties compel him to report facts so entirely contradictory, is beyond the comprehension of any one unacquainted with his very peculiar character.

Very truly yours, JAS. D. SCHUYLER.

An Open Letter.

ALBANY, N. Y., Jan 7, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have received (in an official envelope of the water commissioner of St. Louis) a circular letter submitted by you and 71 other members of the American Society of Civil Engineers, advising me that you have united in support of a ticket for officers of the society for the coming year, and soliciting my vote for this ticket "in the interest of a better administration of the society's affairs, and in the hope of attaining to a higher plane of prosperity and usefulness"—an aspiration which must commend itself to every one.

You will, I trust, not consider me impertinent if I address to you, one of the original nominating committee and one of the foremost advocates of the ticket sent me, a few reasons why I do not think it best to vote for your candidates.

The contest in the coming election is, of course, mainly over the candidates for Secretary. I object to your candidate, Mr. TRAUTWINE, for the following reasons:

1st. Section 4 of Article VII. of the Constitution prescribes that a majority of the candidates for officers of the society, including the Secretary, presented by the nominating committee, shall be Resident Members. I believe the framers of the Constitution intended by this that a majority of the Board of Direction should consist of Resident Members—not Non-Residents nor Associates. I believe the whole history of the society has uniformly been in accordance with this interpretation of the constitution and that its correctness has never until very recently been questioned. I believe the Constitution itself accords with this interpretation and that any other one leads to confusion. For instance, in the third paragraph of Section 1, of Article III., of the Constitution, relating to transfers from a lower to a higher class of membership, it is provided that a proposal for such transfer shall be made by five Members and then be subject to the approval of the Board of Direction. It seems to me it would be an anomalous condition of affairs if a man might, in virtue of being one of the Directors, have perhaps a casting vote on a question of this sort while in virtue of the class of membership to which he belongs he could neither sign such proposal for transfer, nor vote upon it when submitted to the society for ballot. When I joined the society I signed an agreement to be governed by its Constitution. I cannot do this, as I understand the meaning of that document, and vote for Mr. TRAUTWINE for secretary.

2d. I do not consider it advisable to elect as executive officer of the society a man who has shown so little interest in its affairs that, until his nomination at least, he has never attended a single meeting of the society.

3d. Paragraph 2 of Section 3 of Article II. of the Constitution, prescribes that an Associate shall be almost anything except that that he "shall not himself be practicing as an engineer." In the ENGINEERING NEWS of Nov. 15 last, Mr. TRAUTWINE published a card protesting against your statement that he "years ago definitely gave up the active practice of engineering," and asserting on the contrary that "I have always, as a rule, accepted such as came to me." And yet Mr. TRAUTWINE accepted a nomination and election to the society as an Associate and agreed to abide by the Constitution, of which I have quoted a part. I do not deem it advisable to select as executive officer of the society a man who thus shows such ignorance or disregard of its fundamental law.

Among the signers of your letter I notice three of the nominating committee, who have already recommended a different set of names for my ballot. One of these, moreover, has even nominated still another ticket, so that this is the third which he has proposed. His zeal in the attempt to get together a set of names which would hang together until election is certainly commendable.

Enclosed with your letter I find a ballot in proper form for voting together with an explanatory statement of two members of the society from St. Louis, telling how and why your letter came to be sent. It seems that a sort of bureau of correspondence has been existence in St. Louis "to try and obtain a united assent to some one ticket, all of whom were known to be in favor of a more progressive policy in the society," and that the work of this bureau has been mainly carried on by these two members. This being the case, although the explanatory statement is expressly declared to be issued on the individual responsibility of the two signers, the inference is natural that it expresses the views and animus generally of those whose letter it accompanies. My St. Louis friends tell me that in order to accomplish their aspiration and make our society the leading engineering society of America some radical changes in its business management are necessary. They indicate one of these essential changes which is that the Secretary should be required to give his entire time to the work of the office, thereby inferring that the business of the society now suffers in consequence of the present Secretary devoting part of his time to other affairs. Now I am but a comparatively new member. I have much to learn about the society and am trying to learn it. I may be mistaken, but as far as I can find out this idea of the Secretary giving his whole time to the society is something new. I cannot find that it was ever done in the past or ever seriously proposed until very recently, and I consider it unjust to object to our present Secretary on this ground. I have asked your candidate for Treasurer, Mr. BOLLER, whether such was the understanding and practice during his term as Secretary in 1870-71, but have received no answer. Had such been the intention of the framers of the Constitution, I think they would certainly have indicated it, or at least initiated the practice. I am asked, then, to vote for Mr. TRAUTWINE on the gound that he will give his whole time to the society's business, and my St. Louis friends explain that he is a man of means and can afford to do this for the modest salary attaching to the office, implying that the entire time of a competent man is worth more than the society pays. Now this salary either is or is not enough for the work performed. If it is enough let us say no more about it, and not hunt for a rich candidate who will condescend to fill the office. If it is not enough, let us raise it. It is exceedingly humiliating to say to a man, "My dear sir, we want you to give up your whole time to our affairs for at least a year, and perhaps a long series of years. We know the work is worth a good deal more than we are going to pay you for it, but you are rich and can live on your other income, and that is one reason why we ask you." If a man's whole time is demanded and the pay is not enough for it, and a man of wealth and independent income is therefore necessary to fill the office, then why pay anything? Why not let him take it all out in glory instead of only partly recompensing him in that economical way?

My friends enumerate the duties which they consider should be performed by the Secretary, as the editing of transactions, the direction of publications, the care of the library, the supervision of correspondence, the attending at all meetings and the extension of courtesies to non-resident members and visitors. The resident members appear to be left out of the programme. But that same Constitution to which I have devoted some study tells me in Section 2 of Article VI. that the general supervision of correspondence is the President's duty, and in Section 7 of Article VI., that the Library Committee shall have supervision of the rooms, printing and library. Should Mr. TRAUTWINE be elected, then it will be necessary for my friends to have the Constitution altered before he can carry out their wishes fully.

They are careful to inform me that Mr. FORREST, the Secretary of the Institution of Civil Engineers, holds the rank of Associate only in that body, but they do not show equal zeal to advise me that the status of the Secretary of that body is entirely different from the same office in our own society. They leave me to discover from orher sources that the Secretary of the institution is not elected by the numbers at all, but is an appointee of the governing council of that body, and that their choice is not restricted by any constitutional limitations.

My friends assure me that "the issue is in no sense a personal one," yet the present Secretary "*is said* to have been responsible" for "some of the least creditable features of the past management," and that therefore "it would hardly seem wise to perpetuate the evil by electing our former Secretary to the position of Treasurer." They tell me that many of the office methods would "*probably*" be more honored in the breach than in the observance. In the name of all that is fair, if these people have any charges against the Secretary, why do they not state them openly? Why do they hide behind an "*it is said*?" You may be sure that my ballot will never be cast against any man whose opponents employ the disgraceful weapon of innuendo.

My fellow members of St. Louis tell me that Mr. TRAUTWINE gives the most of his time to the revision and publication of his father's books, which work would, of course, have to be abandoned in case he is elected our Secretary and gives all his time to the society's business. This must be looked upon as little less than a calamity by those who have been accustomed to refer to the frequent new editions of his admirable Pocket Book for the latest results of engineering knowledge and practice.

Finally, though not widely known personally among our members, as explained by my St. Louis friends, one would naturally think that a gentleman of so many good qualities would at least receive the most substantial endorsement by the members of the society in his own city. But among the seventy-two signers of your letter to me I do not find a single name of the thirty-eight members residing in Philadelphia. On the contrary I find that seven members in that city have protested against his candidacy by nominating another person for the office.

While I entertain feelings of the utmost respect and good will toward yourself and the seventy-one other signers of your letter, and assure you that any efforts to place the society on a higher plane of prosperity and usefulness will always command my earnest support when I am assured that they are such, for the reasons given I am compelled to refuse to comply with your solicitation to vote for some of the candidates recommended by you.

Very truly yours,

CHAS. F. STOWELL.

Two Devices for Providing Side Motion in Car Trucks.

The question of spring motion vs. rigid trucks in freight service has received very thorough discussion in the railway clubs this season, and some very strong arguments have been made for and against each type of truck. It is argued on one side that swing motion trucks are more complicated and con-

siderably more expensive, both in first cost and cost of maintenance, while the liability of accident with them is greater than with the rigid trucks. It is asserted that practically no benefit is gained by their use, either in ease of carriage or in saving of wear

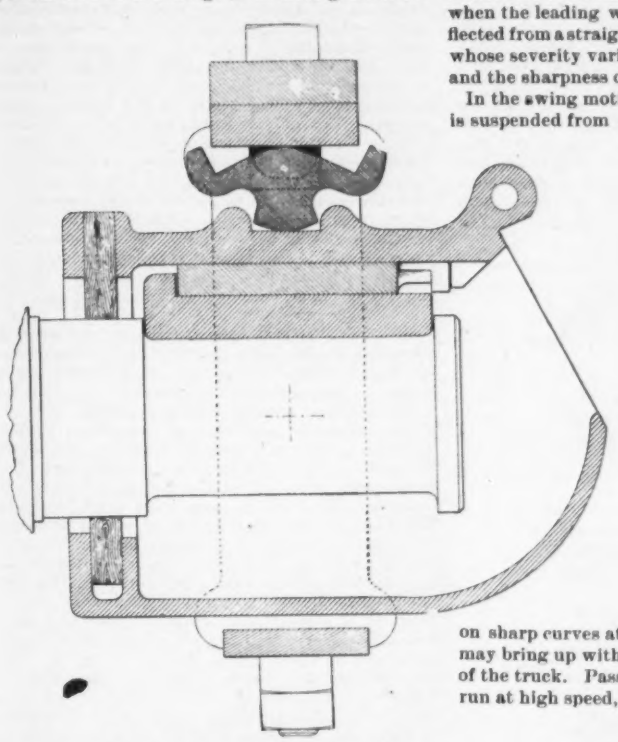


Fig. 1. Cross-Section of Journal Box Fitted with Sisum's Canting Lever.

on wheels and rails, and these assertions are made by men of long experience with both classes of truck.

On the other hand, these statements are contradicted by those of equal experience, who claim that freight rides with much less damage over swing motion trucks, and that with a properly constructed swing motion truck, repairs are no more than with a rigid truck; while the benefits in saving flange wear and repairs to car bodies make it really the cheaper truck to use.

No doubt there has been considerable prejudice and exaggeration on both sides in the discussion, and this makes the truth somewhat difficult to get at; but, viewed from an impartial standpoint, it seems to be pretty certain that a well-made swing motion truck costs more to build than a rigid truck of the same strength, but that the former does carry its load with less shock, especially at high speeds.

To secure the easy motion of the swing bolster truck with the cheapness and durability of the rigid truck, Mr. W. H. H. SISUM, of Brooklyn, brought out some time ago what is known as the canting lever. In the canting lever truck the frame is built as in the ordinary rigid truck; but between the ends of the arch-bars and the top of the journal box is interposed a rocker or "canting lever," as shown in Fig. 1. The curves of the upper and lower surfaces of this canting lever may be so made as to give any desired degree of stability to the car body against lateral motion, but in practice they are so made that at the highest speeds the canting lever never rocks to the extreme limit of its motion. The weight added to a truck by the canting levers is not more than 200 lbs. They are made of hard cast-iron, and the extra expense is very moderate. It will be noticed that the brass used with this box has no end play, as in the M. C. B. standard, and it is claimed that with the canting lever none is needed.

At a recent meeting of the New England Railroad Club Mr. SISUM gave a somewhat novel explanation of the principles of different styles of trucks.

In passing around any curve the trucks of a car assume a position with their axes at an angle to the axis of the car body. This work of turning the trucks on the center pin—"setting the trucks for the curve"—is all done in running the first car length. After that the trucks continue in the same relative position to the car body until the curve is passed. After this car length is run the centrifugal force and the resistance due to the sliding of the wheels are constant, and a rigid truck will ride as easily as a swing motion.

In the rigid truck there is no provision for lateral motion between the car body and the truck; hence when the leading wheel strikes the curve and is deflected from a straight line, a shock inevitably occurs, whose severity varies with the velocity of the train and the sharpness of the curve.

In the swing motion truck the weight of the car is suspended from swing hangers, whose laws of motion are similar to those of the pendulum. When the truck strikes a curve the point of support of the pendulum is pulled to one side and the weight on the lower end by its inertia tends to remain in its former position, while the force of gravity draws it toward a new position underneath the point of support.

The time of swing of a pendulum varies accordingto its length, and the longer a pendulum is the less its rise is for a given lateral displacement. So in swing-motion trucks with long hangers the period of swing is slow and the lift is small and, therefore, on sharp curves at high speed the swing hangers may bring up with a thump against the side frame of the truck. Passenger trucks, which are made to run at high speed, have very short hangers, whose period of oscillation is small and whose lift is large for a given lateral displacement.

In the canting lever truck the period of oscillation and the lift for a given lateral displacement may be varied by changing the curves of the canting lever.

As ordinarily constructed it has a short period of oscillation; and it is claimed by the inventor that, as the canting lever is directly over the axle, the lateral motion of the truck will be more quickly followed bythe car than in the swing motion truck.

Fig. 2 shows a truck for a passenger car, fitted with the Sisum canting lever now nearly completed at the Gilbert Car Works, Troy, N. Y. The car is to run on the Grand Trunk Ry. Fig. 3 shows a design by Mr. SISUM for a 6-wheeled truck, in which the chief novelty is that equalizing levers are dispensed with The nests of springs over each journal are relied on

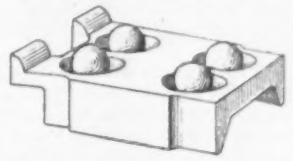


Fig. 4. Wedge with Ball Bearings used in Stearn's Flexible Car Axle-Box.

to distribute the load equally to each axle. Lateral motion is provided for by the use of the canting levers as in the other trucks shown.

The only part changed in applying the canting lever to an ordinary truck is the side frame.

Another device which accomplishes the same object as the Sisum canting lever has been put on the market by the American Railway Equipment Co. of this city. It is known as the Stearns Flexible Car Axle Box. Its principle is the same as that of the

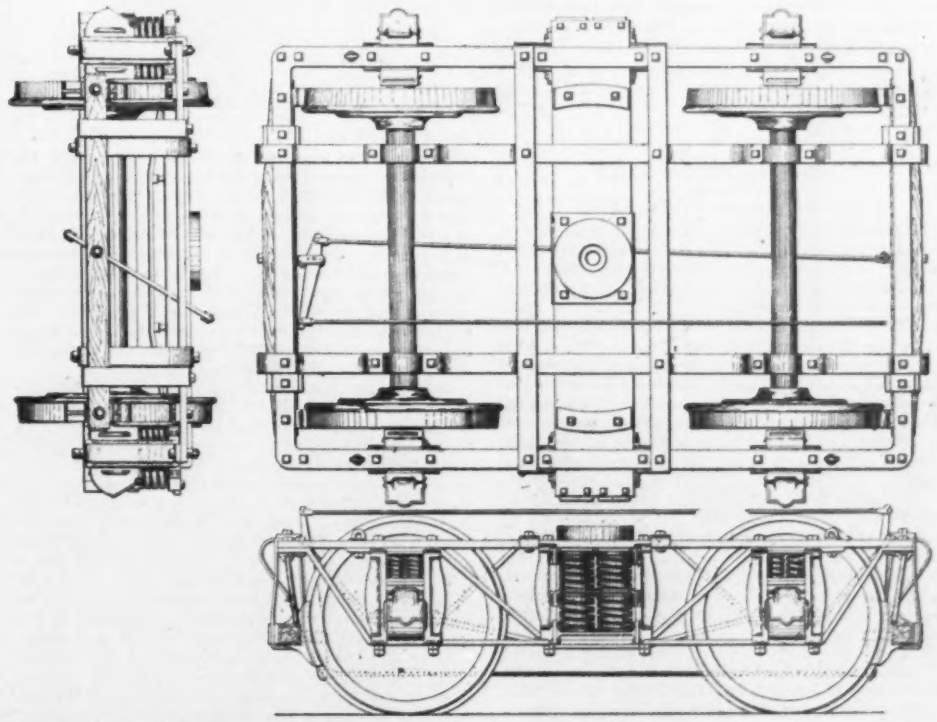


FIG. 2. TRUCK FOR PASSENGER CAR, GRAND TRUNK RY., WITH SISUM'S CANTING LEVER.

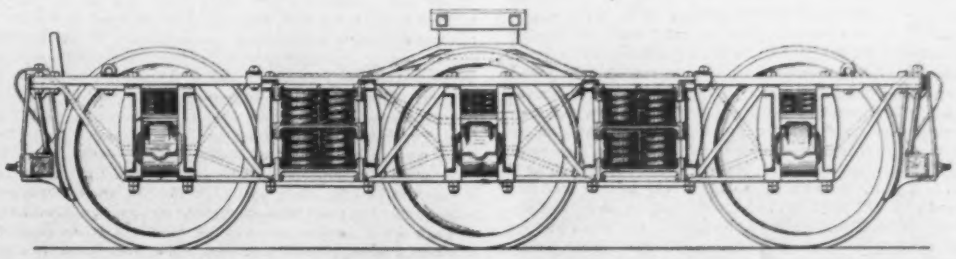


FIG. 3. DESIGN FOR SIX-WHEEL TRUCK WITHOUT EQUALIZING BEAMS.

Sisum 'canting lever, viz., the interposition of a rolling body between the truck arch bars and the journal. In the original design of the Stearns box, several steel balls were placed between the arch bar and the top of the box, resting in hollows on the top of the box, whose radius was larger than that of the balls. This gives practically the same ease of motion combined with stability at the center as the Sisum lever, with the additional advantage that the motion can take place in any direction.

Lately this invention has been simplified and made more easily applicable to existing rolling stock by placing the ball bearings between the wedge and the top of the box. Fig. 4 is a perspective view of the wedge. The balls used are 1 in. in diameter, and roll in hollows in the top of the wedge, ⅛ in. deep and of ⅛ in. radius. The wedge used is a little narrower and ⅝ in. shorter than the ordinary wedge, so that it may move laterally with the brass and journal.

No change is made in the box except that the inside lugs against which the brass strikes are made narrower so as to allow the brass to move laterally, and the boxes are cast a little lower below the dust-guard seat to allow easy exchange of brasses when required.

No change of pedestal, journal, brass or any part other than the wedge is involved by the adoption of the Stearns Box, which is interchangeable with the ordinary standards. Where collarless journals are used it is desirable to use an end stop.

The American Car & Equipment Co. carries in stock M. C. B. standard, Wagner, Pullman and other boxes, and makes to order any required standard, with the Stearns device complete, at 4 cts. per lb., or furnishes the Stearns improvement, consisting of malleable wedges and steel balls without the boxes, at $10 per car of eight wheels.

Thus far this box has been applied mostly on passenger equipment, but it has received high praise for its saving of wear on wheels, trucks, journals and brasses, and its gain in ease of riding in this service, Those interested in the device claim it to be equal to a swing motion truck in freight service as regards ease of riding, and far cheaper in first cost and cost of maintenance.

Subaqueous Foundations.*

(*Continued from page* 581, *Vol. XXIV.*)

This system I had for many years strongly advocated as a means of avoiding the many risks to which sea works otherwise constructed have been subjected. But even with concrete *in situ* so laid under water, other and, perhaps, worse troubles are likely to arise, such as those which have occurred more or less in connection with several works of comparatively recent date, viz., at New York, on the east coast of Scotland, and elsewhere, and which are likely to occur again, unless special provisions are made for preventing the softening or disintegrating of the concrete by a lasting and durable face, composed of neat cement in a plastic state, packed with rubble under water against the faces of the molds, or, in the absence of rubble, by dovetailed blocks of strong, fine concrete, or, by what makes the best of all faces, rubble concrete blocks faced with ashlar, and their beds and joints grouted up below and above low water, such as I have used at Jersey, and which I will presently describe. I believe disintegration has so far been confined to works where concrete has been mixed dry, and then laid under water, or where it has been mixed in the ordinary manner, and deposited immediately thereafter.

During the storms of Feb. 6 and March 10, 1883, a portion of the south pier at Aberdeen was seriously damaged, and when visiting Aberdeen in July and August of that year, in connection with the proposed harbor of refuge there, I examined the breach and concluded that it was a similar example to that of Wick, of the dangerous practice of surmounting a stack of dry blocks, laid under water, by a rigid girder superstructure of concrete above low water, more especially if the blocks are founded on a yielding bed, or on a bed that would be likely to be undermined, that is, on any stratum short of solid rock, for a subsidence of ½ in. or even less, would be sufficient to loosen or leave the blocks free to be acted upon during heavy weather. In this instance, after the blocks had been carried away, the superstructure for 23 ft. in from the sea face, out of a total width of the pier of 35 ft., became a girder of concrete *in situ*, weighing about 2,500 tons and spanning an opening of 90 ft. in length, by 23 ft. in width, by 12 ft. in height. Some of the blocks of the harbor face had been punched out into the harbor, while those in the sea face had been pulled out and strewn on the bottom of the sea for some 20 yds. outwards from the face of the breakwater (Fig. 44). The girder was a very remarkable example of the strength of concrete *in situ* work, chiefly out of water, and of the resistance it successfully offered to the waves, which dashed with such great force into the cavern-like breach. After the withdrawal of the blocks, most engineers would have believed that an unsupported girder of 90 ft. span, subject to such heavy seas as those which made the breach, would have readily given way; but such was not the case, for it remained intact until June 22, when it was cut through at its ends, and dropped down on to a level bed prepared for its reception in the breach. Now, had the joints and beds of the dry blocks under water been grouted up with neat cement, the blocks would have been in place at the present time, and any undermining of them at their basis could easily have been filled in with large rubble and shingle, and grouted up solid with neat cement. The

Fig. 44. Breach in Aberdeen Breakwater.

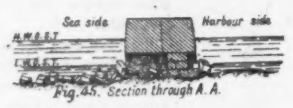
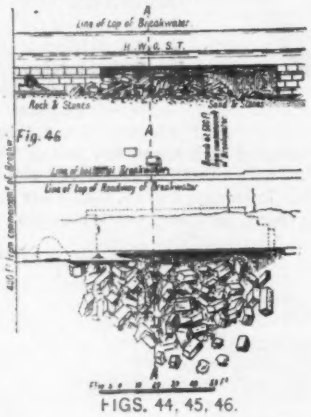


Fig. 45. Section through A. A.

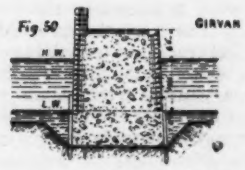


FIGS. 44, 45, 46.

sketches of the breach (Figs. 45 and 46) are from the Minutes of Proceedings of the Institution of Civil Engineers, session 1886-87, page 159. I think it is conclusive that the local subsidences, or inequalities in the foundations, or underminings, caused some of the piles of blocks to be here and there relieved of the weight of the superstructure, and thus they were free to be acted upon by the sea, which soon displaced them, while other blocks were heavily pinned down and held in position by the great weight of the girder, such as the blocks under the ends of the girder, which actually became the abutments or supports of the concrete girder of 90 ft. span.

At Dover, the whole of the dry block work is accurately founded on the solid chalk, and, therefore, there is not the same risk of the blocks settling down and leaving the superstructure locally without support, as there is where the blocks are founded on a rubble mound or on material that is either compressible or easily removed by undermining. The next step in advance, in forming subaqueous foundations, was that of the bag system, which for rough work not subjected to such very heavy seas as those at Wick, has answered upon the whole fairly well, and I believe was first adopted at Aberdeen by Mr. W. D. CAY With this system it is almost impossible to carry on important work continuously and economically, and I fear, as far as my knowledge serves me, that, as a whole, it is not only more costly than even the best class of grouted up block masonry, but it retains some of the evils of the old dry block system, such as crevices and disintegration of concrete *in situ*, although covered by bagging, and, therefore, it cannot be regarded as permanent, which all public works of this class should be. With the grouted up block system the works can be carried on almost continuously, for when the divers and others at the scar end of the work are thrown idle their labor can largely be utilized in the block yard and elsewhere, but not so with the bag system, which cannot be economically carried on, except in localities where there are comparatively long periods of fine weather; and, further, after long experience, I find in the former system most excellent and durable blocks can be formed with 1 ton of cement to 11 tons of rubble, dressed ashlar and coarse sand. With these proportions blocks of 9 and 12 tons weight have been made in large quantities and lifted from their molds within four days, but with the bag system it is necessary to use more than double the cement in order to obtain work of similar strength. Most of the structures to which I have referred may be taken as representative examples of the gradual progress in the construction of breakwaters during the last 60 or 70 years.

As to disintegration. In order to obtain sound work under water, and to make a good face, it is far better to dispense with the ordinary concrete *in situ* for the face work, and to use slightly moistened and partially set neat cement, with or without an admixture of Medina cement, depositing the same by facing skips next the timber face of the mold, and afterward for a driver to pack as many rubble stones into it as it will take, pushing their flat faces hard up against the timber mold, or in the event of stone suitable for facing not being at hand, then substituting small strong blocks of fine concrete for the purpose. The ordinary five to one backing of partially set concrete could be carried up simultaneously with the facing work. This facing work of say 12 ins. or 18 ins. in thickness, although somewhat costly, would add but a small percentage to the entire cost of the work, in cases where there is considerable width of backing, or in the case of a pier of great width. Facing work in these materials may be classed next to grouted up block work, but it is immeasurably inferior, as frames are required, and it is only in moderately fine weather that such work can be done successfully. As to whether the rapid deterioration of Portland cement concrete, from a few feet above to a few feet below low water, is due to bad cement, insufficient quantity of cement, or bad workmanship, has not yet been satisfactorily answered. Let me give an instance or two. Prior to 1877 a large number of from 70 to 90-ton blocks for the Hermitage Breakwater works at St. Helier, Jersey, were made *in situ* in the Victoria Harbor at about the level of low water of neap tides. These were covered at each tide and subjected to a wet and dry action from the time they were made down to the year 1885, when, as they were found to be utterly useless for building purposes, they were broken up, and the débris filled in behind the new north quay. What took place in Jersey is by no means the exceptional case, for something very similar has occurred in connection with the New York Harbor quay walls, as described in my first lecture, Maryport Dock, the graving dock at Aberdeen, and at other places on the east coast, and I have no doubt that if many of the recent concrete *in situ* works were examined by divers, enough would be revealed as to softened and disintegrated concrete face work to shake the confidence of most engineers in the further use of concrete *in situ* for first-class works. In one case which came under my immediate notice, viz, at Girvan, I found that in a portion of the north pier or groyne, which was executed with every possible care in 1882, the outer face of 12 ins. in thickness, which was composed of four parts of coarse sand and fine shingle to one part of cement, and the hearting of six parts of coarse sand and shingle to one part of cement, with as many large-sized rubble blocks as could be placed in the mortar without touching each other, had become most seriously disintegrated within about twelve months after its completion, and ultimately it wasted away, until there was a breach of the form shown in Figs. 47 and 48. The concrete was mixed and put into the frames at the same time, in the same manner, and by the same men; not allowed to partially set for a few hours before being deposited in a plastic state, but as ordinary concrete for dry work is mixed and deposited for work out of water. The base was



FIGS. 47, 48, 50.

founded at low water mark, and the compartment was filled up to coping level within five hours, thus keeping about an hour or two in advance of the rising tide.

On examinining the cause of the breach, I found the portion at *A* as soft as garden mold, at *B* soft, *C* just hard enough to crumble in my hand, *E* hard, *F* to *G* very hard, excellent work which resisted a heavy blow of a hammer. Probably the cement used was a portion of a cargo which contained a large percentage of unburned cement.

Recently I have made some inquiries of the harbor engineer at Aberdeen as to the plastic concrete used in the quay walls there in the year 1882, and I learned that it is still tough, and in good condition. Some of the advantages of the subaqueous grouted block system are that the rubble blocks, which are shallow grooved and bat tongued on all sides, can be made in the usual manner in the block yard, in almost all weathers, by the cheapest of labor, and when it is impossible to carry on block setting and grouting at the scar end, the labor thus thrown idle being utilized in the block building yard in

* By Walter Robert Kinipple, M. Inst. C. E., reprinted from *Engineering*.

aiding the ordinary workers. In block building, the best and most suitable of material can be used with every advantage and economy, and under thorough inspection.

At the Hermitage Breakwater, where the blocks were of two sizes, viz., 9 and 12 tons, and averaging 10½ tons throughout the work, the average weight of cement used per ton of rubble and ashlar built into these blocks was about 200 lbs., or one-eleventh of the weight of materials cemented together, but a good job could be made with one-twelfth, that is one-thirteenth of the weight of the block, being cement. The mortar for the rubble jointings was composed of four or five parts of coarse sand to one of cement, and the mortar in the joints of the facing ashlar, and at any corners or arrises where extra strength was required, was two of sand to one of cement. The face joints were raked out for an inch in depth, and pointed with neat cement.

I have in the sea works for which I have been engineer carried on the monolithic system; thus at Girvan Harbor, Ayrshire, where I constructed a sea pier and a groyne, together about 1,200 ft. in length, and both were solid throughout. On Fig. 50 is shown a section of the south pier, founded at 17 ft. below high water, or 7 ft. at low water. The portion below low water was first constructed within a piled trench, the concrete for which was deposited *in situ* after being allowed to set for a short time. Owing to the great trouble experienced in keeping the joints in the sheeting piles and the lining of flooring boards even when covered with canvas cement-tight, and preventing the mould from vibrating during heavy seas, I abandoned timber framings altogether, and used handy-sized dovetailed concrete blocks (see Figs. 10 and 11 given on page 534 *ante*), which answered exceedingly well, and these, together with the backing and grouting up, were all executed without further trouble or risk. A fine concrete of three to one was used to back up the blocks, and the hearting was of four to one fine cement concrete, with as many blocks of stone, or broken boulders, as could be inserted into it, having joints of fine cement of a few inches in thickness between each block.

In Mr. Vernon Harcourt's work on "Harbours and Docks," 1885, under the head of "Construction of Superstructure," page 114, it is stated: "The lower courses of the superstructure, being laid below low water, cannot be cemented together;" and again, at page 115: "Below low water no means could be used for filling up crevices, and the waves rushing caused a compression of the air inside them;" again, at page 126: "When the bottom is several feet below low water, it entails both the cost of building under water and also the weakness of uncemented blocks;" and at page 127: "The weakest part of an upright wall founded below low water is close to the level of low water, where the uncemented blocks are liable to be forced out by the waves compressing the air through the joints;" and on the same page, as to the "limits of application of the upright wall system," "the enhanced expense would preclude the erection of an upright wall in deep water." "The greatest depth in which an upright wall has been founded is in 40 ft. of water at Dover, and the great cost in this instance does not furnish an inducement for imitation elsewhere." From these quotations it would appear that no attempt by other engineers than myself had, up to 1885, been made to cement blocks together under water. Now, in the system I have inaugurated at the Hermitage Breakwater, Jersey, not only has the upright wall system been executed in 60 ft. at high water and 20 ft. at low water, at extreme springs, but the whole of the rubble foundation bed, for several feet in thickness, has been cemented into a solid mass, in addition to the whole of the blocks having been cemented together under water from the foundation upward; and, further, the whole of their faces have grooves and projections, which render it next to impossible for any of the blocks to become dislodged, even should they not be cemented together. These improvements have in fact, put an end to most, if not the whole, of the risks of failure which hitherto seem to have been, from some cause or other, almost inherent in every method of construction yet used, more especially where blocks have been laid dry under water.

In order to make sure and to give confidence if possible to those who up to 1882 had doubted my system of grouting—and I am sorry to say almost every engineer I know still doubts it—some experiments were carried out under my direction by Mr. William Smith, harbor engineer at Aberdeen, in July, 1883, and also by Mr. G. H. Spencer at St. Helier, Jersey, in November, 1884, to ascertain whether the system of grouting I had adopted for the bed and joints below low water of the face blocks at Girvan, might be advantageously extended. At Aberdeen a timber box 6½ ft. long, 12 ins. wide and 4 ft. deep was filled with round smooth shingle and pieces of whinstone from 1 in. to 4 ins. in diameter, and was lowered to the bottom of the tidal harbor in a depth of 18 ft. at high water of spring tides, and having a wrought iron pipe 3 ins. in diameter, the lower end of which was inserted into the box for about 12 ins., and long enough for its upper end to stand a few feet above the water level. At high water a very thick grout, composed of four parts of neat fine Portland cement and one part of Sheppy cement, was poured down the pipe in sufficient quantity to fill up the whole of the interstices. After 12 days the box of concrete, which weighed nearly 2 tons, was actually lifted out of the water by means of the 3½-in. pipe alone, which, although only inserted for 12 ins., had become so firmly cemented into the concrete as to admit of this being done. On removing the sides of the box, the concrete was found to have a smooth surface, and to be perfectly solid throughout. At Jersey,* two experiments were made by Mr. G. H. Spencer, in November, 1884, under my direction. First, a box of about 6 ft. cube was filled with shingle, and a gas pipe of 1½-in. diameter was inserted 18 ins. into it, and when the tide had risen 20 ft. above the box, thick neat Portland cement grout was poured down the pipe. On opening out the box, its contents were found united into a solid mass, with the grain of the rough sawn timber of the box imprinted upon the surface of the concrete, so completely had the grout filled up all the interstices of the box. Second, a box of 2 ft. cube, filled with shingle, was suspended in a depth of 60 ft. of water in the strong tideway just outside of the Little Roads. A thick grout of Portland cement was poured through a tube reaching nearly down to the bottom of the box, which united with the shingle into a concrete block. The block is here on the table, and is really the parent block of my new system of constructing subaqueous foundations in great depths of water, and, as far as I can judge, it can be done with equal success in 200 ft. or 300 ft. of water as in 60 ft. of water. The block is not so perfect as in the first experiment, owing to the bottom zinc tubing being crushed by the weight of the iron tubing above, which allowed the grout to escape; the failure, however was only partial, for one-half of the block was thoroughly solid, and had sharp arrises.

These experiments confirm those I made in 1856-8, in endeavoring to prove the feasibility of cementing shingle together in foundations at great depths, grouting up fissures and repairing structural works undermined, or wasted away by the action of the sea or scour. It is somewhat remarkable that, although it is now nearly a quarter of a century ago since I described some of these experiments at the Institution of Civil Engineers, in 1885 Mr. Vernon Harcourt should have published the statements that the bed and joints of courses of concrete blocks laid below low water cannot be cemented together, and also that below low water no means could be used for filling up crevices. Again, that the engineers who took part in the discussion on "Concrete as Applied in the Construction of Harbors," at the Institution of Civil Engineers, session 1886-87, should doubt or condemn the system without making such inquiries as would enable them to conduct experiments in such manner as would insure success.

In 1882, I succeeded in stopping considerable leakages at an old graving dock in the west harbor at Greenock, which had given so much trouble for years, as to lead to proposals for reconstructing or removing it altogether. Boreholes were made 1 ft. to 2 ft. apart, through the masonry behind the heel posts down into the sandy foundation for several feet below the masonry foundations, and also down through the inner and outer aprons near the pointing sill, in which latter holes standpipes were set up. A thick grout of neat Portland cement was poured down into these holes and permeated the various fissures and open joints to a distance, in some places, of 18 ft. from the boreholes, virtually joining the boreholes together, and thereby forming a water-tight sheeting of neat cement. The quantity used in grouting up these holes was about 5 tons. The grout was only poured down the stand pipes when the water was at the same level inside and outside the dock. The level of the grout inside the pipes, during the grouting operations, was several feet below the water level outside of the pipes, and this varied with the tide. Before these operations were carried out an 18-inch pump was constantly working to keep down the leakages, whereas subsequently only one hour's pumping was required in 40 hours.

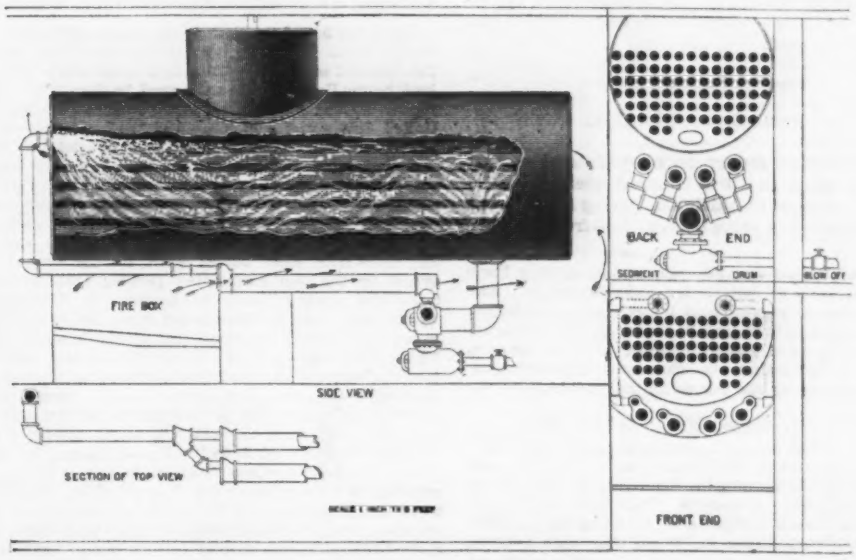
(To be continued.)

* See Minutes Inst. C. E., vol. lxxxvii, 1886-87, p. 166.

The Elmira Steam Generator.

We illustrate herewith a rather novel attachment for increasing the capacity of a boiler. The ordinary method of effecting this is by the use of a feed water heater or fuel economizer, through which the gases from the fire pass after circulating around the boiler and through the tubes. In this device the additional heating surface is placed just back of the bridge wall and the gases pass through it immediately after leaving the fire. Evidently the heating surface placed in this position, will have a high rate of evaporation. Since the total amount of heating surface is increased, some gain in economy ought to result, although this would hardly be so great as would be secured by a feed water heater using the waste gases.

The construction of the apparatus is shown in the accompanying illustration. The tubes of the generator are double, as shown in the end views, and the gases pass both through and around them, thus securing a large area of heating surface in a small space. Circulating pipes connect the generator with the boiler at each end, and a mud drum connected as shown, catches the scale and sediment from the boiler, and permits its discharge at the blow-off.



ELMIRA STEAM GENERATOR.

It would naturally be expected that the apparatus would fill up with scale very rapidly, and would soon burn out; but it is claimed that instead of this the circulation produced causes all sediment to collect in the mud drum, and keeps the boiler clean as well as the generator. The apparatus is claimed also to be very durable, and to have been run for nearly five years with no expenditure for repairs. It is made by the Elmira Steam Generator Co., of Elmira, N. Y.

Casting a Screw Thread.

In our issue of Oct. 4 we briefly described a novelty in shop practice in use by the Howard Iron Works of Buffalo, N. Y., which has resulted in a very considerable economy of labor, tools and material over the old method. It consists in casting the female screw thread in the base of adjustable shaft hangers instead of reaming out the cored hole and cutting the thread in the lathe according to the usual custom. The adjustable shaft hanger has been found especially valuable for use on the long line-shafts of grain elevators, where the shaft sup-

ports are very liable to get out of line as the foundations settle.

For the benefit of any of our readers who may have occasion to use this process the following particulars have been furnished us by Mr. GEO. F. MAYER of the Howard Iron Works:

The core box, which is the most important part, is made of iron with joint planed and doweled, and the thread in same is cut in the lathe. The threads are square and are cut slightly tapering, so that the core box may be taken apart without injury to the threads on the core. The threads in the core box are also cut $\frac{1}{8}$ in. per ft. longer than the standard, and $\frac{1}{16}$ in. larger than the screw to allow for shrinkage of castings. Great care must be taken to have full threads on cores. We have not as yet cast anything smaller than 2½ ins. outside diameter, and 2 threads per in.; but we see no reason why smaller threads and pitch cannot be cast in same manner. In drying the cores, we use a semi-circular shell of cast iron of about the shape of the hexagonal brass for a car axle box. This is bored out true, and so keeps the core straight while being dried. We have cast successfully the above size threads in journal box nuts varying from 8 ins. and downward. The threads on the adjusting screw were cut by passing once over the work with a Schlenker bolt cutter of which we are the manufacturers.

Of course a cast screw thread would hardly do where great accuracy of movement without "backlash" is desired. But for large size castings which are inconvenient and expensive to handle in the lathe, and for many cases where accuracy is not essential, the process might well be better known and more widely used.

Paris Street Cleaning.

The following matter on methods and cost of street cleaning in Paris is mainly gleaned from a long letter to the Philadelphia *Evening Bulletin*, but is accompanied by some observations from another source:

The work of cleaning, sweeping and sprinkling Paris streets is done by *embrigades* and *volontaries*. The former class are regular road laborers, employed for the whole day and to their lot falls the supplementary sweeping, washing out of gutters, cleaning of public urinals, stations, market houses, etc. The second class are practically employed by the job or for the time required by their service.

The *volontaries* are enrolled in about 130 brigades, each headed by a chief or foreman and including about 30 male and female sweepers. The greater part of these people work early in the morning in cleaning up the streets and loading the débris on wagons. Their labor begins at 3 A. M. in the summer and at 4 A. M. in the winter, and they usually quit work at 10 A. M. When they work a whole day of 12 hours they stop at 4 P. M. The entire service of sweepers for the city comprises 37 chiefs, 152 foremen, 654 ordinary road laborers, 2,000 sweepers and 850 men and women who do only a half day's work. Overseers, foremen and the regular road laborers are paid monthly at the rate of $30 to $32 for the first, $24 to $25 for the second and $21.20 for the third class. The sweepers are paid for the work they do, at rates ranging from 64 to 76 cts. for a whole day and 43 to 50 cts. for a half day. Out of his pay each regular road laborer or *cantonnier* must pay monthly $1 into a saving fund. The amount thus deposited is paid to him when he leaves the service, or to his heirs if he dies while in service. A further deduction of 40 cts. per month is made from the men employed in the Bois de Boulogne or Bois de Vincennes for a mutual aid society.

Women sweepers use the ordinary birch broom, or one made from vegetable fiber. Road scrapers are handled by the men, who also use larger brooms in pushing the water and mud to the sewer openings. The scrapers and brooms used in this latter service are fitted with bands of rubber, that insure a clean job. The sweeping machines are powerful and of the ordinary rotary, two-wheeled type. The cost is given at $200 each, and their sweeping capacity is 6,000 sq. yds. per hour. The area to be cleaned in Paris is divided into central and suburban, and these again into sections and quarters. The central area, cleaned daily, is given as about 8,400,000 sq. yds., and the suburban districts cover 10,800,000 sq. yds.

The last annual appropriation for cleaning and sprinkling and clearing away snow and ice was $1,363,000. The sweeping service called for a total of $1,150,000. The city raises its share of this amount by a tax imposed on house owners, revised every five years. The Departments of State and of the Seine contribute for their share of the sweeping. The tax of the house owner is 14 cts., 10 cts., 4 cts., or in some cases less than 1 ct. per superficial meter of land, for the care of which he is held responsible.

Municipal statistics are given by the writer as follows: Sprinkling by carts costs .002 cts. per sq. yd. (0.12 centimes per sq. meter), on streets paved with stone, and .001 ct. per sq. yd. on streets paved with wood. Sprinkling with hose and pipe costs still less. On paved streets a cart can sprinkle 24,000 sq. yds. per day. On macademized streets, owing to the more rapid absorption of water, half of this area only can be sprinkled in a day. The tendency seems to be to increase the hose sprinkling method, as being more economical than carts.

The hose referred to by the writer is made of about 10-ft. sections of 1-in. iron pipe joined by a section of rubber hose, and has at each joint a pivoted two-wheeled truck of small diameter. The combined hose may be 100 ft. long, and by attaching it to a pavement hydrant it commands a length of 200 ft. of the street. It is easily manipulated or stowed away and is serviceable.

The United States-Nicaragua Canal Treaty of 1884.

In the discussion of boundary complications between Nicaragua and Costa Rica, affecting the Nicaragua Canal Co.'s concessions, the United States Senate made public a treaty signed on Dec. 1, 1884, between the United States and Nicaragua. The treaty was accompanied by a letter of transmittal from President ARTHUR strongly arguing the necessity of this canal for political and commercial purposes. It was to have been ratified within two years, but was not so ratified. In speaking of the document a Washington dispatch to the press says:

This treaty bound the United States and Nicaragua to build a canal. The treaty itself is made up of 25 articles. The first and second articles read that the canal shall be built by the United States and owned by them and Nicaragua. There shall be a perpetual alliance between the United States and Nicaragua, and the former agrees to protect the integrity of the territory of the latter. The other articles provide in brief that the canal shall be of the largest class of ship canals; that the United States shall have the free use of Lake Nicaragua; that the United States shall pay for the private lands used; that a strip of land twenty-two and a half miles wide shall be set apart for the work and owned by the two contracting parties; that no custom house charges shall be imposed by Nicaragua upon vessels passing through the canal, and that Nicaragua shall protect the canal employees. In return the United States agrees to furnish the money and build a canal railway and telegraph lines and equipment; that it shall have exclusive control of the canal construction and that the canal shall be managed by a joint board; that the profit from the tolls are to go, one-third to Nicaragua and two-thirds to the United States; that the United States disavow any attention to impair the independence of Nicaragua or her sister republics; that the canal shall be commenced in two years and completed in ten years; that the United shall aid by its good offices, if desired, in securing the union of the five Central American republics, and that the United States shall lend Nicaragua $4,000,000 to make internal improvements, to be a lien on the canal.

The Western Traffic Association.

The new alliance among the Western railways for the prevention of rate wars and as many other forms of competition as its managers can control was completed in New York City Jan. 10. The preliminary meeting, at which the basis of organization of the new association was decided upon, was described on page 541 of our issue of Dec. 20. Since the preliminary meeting the boards of directors of each of the several companies have ratified agreement, and at the recent meeting in New York the working details of the association were arranged.

The essential features of the agreement under which another great endeavor is to be made to secure harmony are as follows: The affairs of the association are to be under the management of an advisory board, composed of the President and one member of the board of directors of each company represented. This advisory board is to establish and maintain uniform rates between competitive points, decide "all questions of common interest between members of the association," and have entire charge (through properly constituted representatives) of all outside agencies for securing traffic at competitive points. If any officer or representative of any company authorizes or promises, directly or indirectly, any variation from established tariffs, he is to be discharged. The association is to continue for at least six months from Jan. 1, 1891, and no company may withdraw after that time without giving 90 days' notice.

At the New York meeting, by-laws were adopted providing that the business controlled should be all competitive traffic to or from all points west of the Mississippi River and in the States of Illinois, Wisconsin and the North Michigan peninsula, except traffic to and from transpacific ports and traffic between points north and points south of the Ohio river. Practically the affairs of the new association are to be carried on by five commissioners, who besides the rate-fixing power heretofore given to them are to arrange for an equitable division of competitive traffic between the different roads, whenever any road believes it is not getting its fair share and makes application for such a division. The commissioners elected are: Messrs. ALDACE F. WALKER, Chairman, and J. W. MIDGLEY, J. N. FAITHORN, W. W. FINLEY, JAS. SMITH and E. P. VINING. The officers of the association were chosen from the presidents of the various companies as follows: ROSWELL MILLER, C., M. & St. P., President; MARVIN HUGHITT, C. & N. W.; JAY GOULD, Mo. Pac. and U. Pac.; R. R. CABLE, C., R. I. & Pac.; THOS. F. OAKES, No. Pac.,; and ALLEN MANVEL, A., T. & S. F., Finance Committee.

The new association comprises all the important companies doing business west of Chicago and St. Louis except the Chicago & Alton; Chicago, St. Paul & Kansas City; Kansas City, Fort Scott & Memphis and the Missouri, Kansas & Texas, with some Arkansas and Texas lines which are in the hands of receivers.

The problem now is how long the new association is likely to endure. The Chicago, St. Paul & Kansas City and the Chicago & Alton are not only not in the new association but are likely to do more or less to disturb its peace and harmony. The inherent weakness of the new association, however, as of all others which have preceded it, is that the members are held together by a rope of sand. The agreement, which has been assented to by formal vote of each board of directors and has been signed by each board of directors would, if all precedents were followed, be declared null and void by the courts, it being a contract in restraint of competition. There is, however, a possibility that this ancient principle might be reversed, if the case were carried to the highest courts as some case of the kind is bound to be, sooner or later.

There is little likelihood, however, that the courts will be asked to enforce the present agreement, since the publicity which would be caused would be apt to result in legislation disastrous to the railways. The probabilities are that the new association will pursue the even tenor of its way, each member gradually slipping away from a strict observance of the agreement, because his neighbors do, until it will quietly go to pieces like others which have preceded it.

Meanwhile the foundations for a permanent consolidation of Western railway properties under a joint ownership are all the time being perfected. The recent financial stringency and the drop in stocks which it has caused, has afforded the "multimillionaires" a chance to secure a large amount of stocks which small holders were obliged to sell. This concentration of ownership in the hands of a few very rich men, will probably lead to some arrangement by which all the Chicago systems, and perhaps the systems of the Southwest and Northwest as well, will be owned jointly, and their receipts will be turned into a common fund. When that time comes it is needless to say that competition among the several companies will be at an end.

CONCRETING UNDER WATER.—In *Indian Engineering*, of Dec. 6, Mr. H. WHITE, M. I. C. E., publishes some important additional notes on his previous article on concreting under water, of which an abstract appeared in our issue of Dec. 20. Mr. WHITE says that the concrete deposited as there explained was examined from 10 to 15 days after the experiment was made. When broken up he found that the cement concrete was thoroughly permeated and set into a mass sufficiently hard for plugging wells. But the hard setting qualities of the cement were impaired by the excess of water.

The concrete made as described of fat Burma lime and powdered brick, or *surkhi*, had *not* set, and after waiting two months it was still too soft to be useful for plugging wells. Mr. WHITE thinks this is owing to the fatty nature of the Burma lime.

ELEMENTS OF WEATHER IN THE UNITED STATES, OF MOST INTEREST TO ENGINEERS, FOR THE MONTH OF DECEMBER, 1890.

[Furnished to ENGINEERING NEWS by the Chief Signal Officer, U. S. A.]

STATION.	Temperature. (Deg. Fah.)				Wind.			Precipitation.—Rain and melted snow. Inches.		
					Velocity in miles per hour.					
	Average.	Max.	Min.	Range.	Average.	Maxim.	Direction at time of max. velocity.	Total.	Heaviest in 24 hours.	Number of rainy days.
NORTHERN CITIES.										
Northfield, Vt	9.2	41	—22	63	9.5	48	*	1.91	0.64	16
Portland, Me	17.2	41	—4	45	7.3	36	NW	5.08	1.54	15
New York City	31.4	54	13	41	5.1	48	NE	5.43	1.87	13
Pittsburg, Pa	32.1	52	16	36	6.6	27	NW	5.64	2.35	18
Chicago, Ill	30.5	53	—8	45	18.3	54	SW	1.25	0.47	8
Omaha, Neb	34.6	71	5	66	7.2	36	NW	0.08	0.08	1
St. Paul, Minn	24.0	53	—3	56	7.0	29	NW	0.10	0.06	6
Duluth, Minn	22.6	50	—5	55	7.0	34	W	0.19	0.09	6
Bismarck, N. Dak	21.9	64	—7	71	9.4	58	NW	0.22	0.08	5
Average	25.2	53.2	0.1	53.1	9.8	41	.....	2.21	0.80	10
SOUTHERN CITIES.										
Washington City	34.0	60	18	42	6.0	45	NE	3.74	1.73	13
Louisville, Ky	38.8	59	17	42	8.6	31	W	3.06	1.12	12
St. Louis, Mo	37.6	63	17	46	12.7	36	NW	1.32	0.82	7
Savannah, Ga	51.8	77	31	46	7.3	38	W	2.92	1.33	8
Leavenworth, Kan	37.0	70	12	58	5.2	29	SW	0.40	0.31	2
Jacksonville, Fla	55.9	80	30	50	6.7	40	W	1.37	0.66	6
Chattanooga, Tenn	44.8	65	26	39	6.9	33	NW	3.13	1.24	11
New Orleans, La	56.4	80	35	45	10.0	27	SW	2.58	1.74	3
Memphis, Tenn	46.0	73	23	50	7.3	35	W	3.64	1.24	7
Palestine, Tex	53.4	81	23	58	6.5	24	SW	1.27	0.51	7
Average	45.6	70.8	23 2	47 6	7.7	34	.....	2 34	1 67	8
WESTERN CITIES.										
Helena, Mont	30.0	54	2	52	5.0	60	W	0.82	0.49	12
Port Angeles, Wash	...	...	...	...	...	...	...	...	...	...
San Francisco, Cal	49.7	60	39	21	6.4	36	SW	3.95	1.90	6
Salt Lake City, Utah	36.0	57	20	37	3.0	25	S	0.42	0.22	5
Denver, Col	39.3	70	14	56	5.5	46	NE	0.04	0.03	2
Yuma, Ariz	60.2	77	35	42	7.0	36	W	0.32	0.31	5
Santa Fé, N. Mex	34.6	52	15	37	7.0	40	NE	1.60	0.61	8
Average	41.6	61.7	20.8	40.8	5.6	40	.....	1.22	0.59	6

* N W and S W.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads

New York Central & Hudson River.—Vice-President H. Walter Webb is quoted as saying that the line from Utica to Clayton, N. Y., would certainly be built, and that construction would begin as soon as the weather would permit. The road will be about 170 miles long and will cost about $6,600,000.

Cleveland, Cincinnati, Chicago & St. Louis.—Assistant Chief Engineer Hermann of this company has completed his survey of a line from Harrison, O., to Richmond, Ind., and has the estimates of cost of the construction on the last surveyed line ready to submit to the proper officials. He places the cost of building the first 8 miles out of Harrison at $20,000 per mile, and the last 6 miles before getting into Richmond at the same figure. The line surveyed is 39 miles long, and the remaining 25 miles he estimates can be built for $10,000 per mile, ready to run trains over. Thirty miles of the line located is an air line.

Washington & Potomac.—A press dispatch says:

William J. Best general manager of the New York Improvement Co., is calling for laborers to work on the Southern Maryland R. R. between Brandywine and Mechanicsville, Md. The road will probably be in running order to Mechanicsville early in February next. Two locomotives and 18 cars have been bought for the road. The rights of way secured by this company contain a proviso declaring that they are to be null and void unless the road is completed and cars are running over it to Point Lookout on or before March 31, 1892.

New York, Susquehanna & Western.—This company has made a mortgage of its property to the Central Trust Co., of New York City. Of the $3,000,000 bonds authorized under this mortgage, $1,000,000 are to be used for the construction of additional tracks, the purchase of new equipment, the erection and equipment of shops and for advances to be made to coal producers for the securing to the company of additional coal tonnage.

Philadelphia & Seashore.—Work will be commenced soon on the extension from Tuckahoe to Sea Isle City, N. J.

Clarion River.—B. E. Wellendorf, of St. Mary's, Pa., Chief Engineer, writes us that 6 miles of this railway from Carman Station to Halltown, Pa., 12 miles, have been completed, and that the remainder of the line will be finished early next summer.

Projects and Surveys.

Boothbay.—C. H. Fisher, of Boothbay Harbor, Me., writes us that this road is projected to run from tidewater in Boothbay Harbor, via Boothbay, Edgecomb and New Castle to the Penobscot Shore Line R. R., a distance of 13 miles. The location has been finished. The principal business will be the summer tourist travel and the general shipment of merchandise to and from the vessels entering the harbor. The company was chartered in March, 1889. Thomas Boyd, President; Henry A. Hancox, Chief Engineer; and C. H. Fisher, Treasurer.

Cumberland & St. Lawrence.—Newton S. Parmelee, of Malone, N. Y., President, writes us that this road is projected to run from the St. Lawrence River, at Valleyfield, P. Q., via Malone, N. Y., through the Adirondack Mts., to Schenectady, N. Y., about 220 miles. The surveys have been completed from Valleyfield to Malone and contracts let for building 30 miles of the line. C. D. Maze, of 180 St. James St., Montreal, P. Q., is the engineer in charge of the surveys. The company was chartered Dec. 11, 1890.

Clay Valley & Lehigh.—We are informed that there is no immediate prospect of any work being done on this Pennsylvania railway.

Troy & New England.—J. J. Tillinghast, of Troy, N. Y., Treasurer, writes us that the surveys have been completed for this railway from Troy to the Massachusetts State line, 40 miles. The road will pass through the towns of Sandlake, Nassau, Malden and Chatham. There will be one tunnel. It has not been decided when work will begin.

Turtle Creek Valley.—Chartered in Pennsylvania to build a line of railway 4 miles long. Directors, L. E. Love, Wilmerding, Pa.; Geo. V. Milligan and R. P. Kelley, of Pittsburg, and J. W. King and John S. Miller of Edgewood, Pa.

Annapolis Atlantic.—Chartered in Nova Scotia to build a railway from Annapolis to Liverpool and Shelbourne. R. G. Henry, Brockville, Ont., President.

Indiana.—A press dispatch says:

Surveyors are near Silverville, Ind., surveying a route for a railroad to be run from Terre Haute, Ind., to Louisville. The chief engineer says that if a good route can be found, the road in all probability will be commenced. This will open immense coal and stone deposits in Green and Lawrence counties, Ind.

SOUTHERN.—Existing Roads.

West Virginia & Pittsburg.—The contracts have been let for an extension from Flat Woods to Laurel Creek, W. Va., a distance of 12 miles. The contractors are Shirr & Neely, 8 miles, and Joe. Fudcey, 4 miles. The contract for the bridge over the Elk River was let to F. H. Blodgett.

East Tennessee, Virginia & Georgia.—This company has filed a mortgage for $15,000,000 with the Central Trust Co., of New York City. The proceeds are to be used in building extensions, branches, etc., and in double tracking the main line.

St. Cloud Sugar Belt.—It is announced that this road will be extended from Narcoosa to Orlando, Fla., via Conway, Fla.

Atlantic Coast Line.—Proposals are invited for the graduation and trestle work of the road from Fayetteville, N. C., to Rowland, 42 miles. The work will be divided into nine sections of about five miles each. Bids may be made for a section or sections or for the whole line. The trestle work will be mainly of driven pile work. Bids for trestle work may be made distinct from or in connection with the grading. Plans and profiles and specifications can be seen at the office of the Wilmington & Weldon R. R., in Wilmington or at Fayetteville. Bids will be opened and contracts awarded on the 20th day of January, 1891. Work to be completed on or before the 1st day of August, 1891. Fleming Gardner, Engineer of Construction, Wilmington & Weldon R. R. Co., Wilmington, N. C.

Augusta, Tallahassee & Gulf.—This road has been sold to a syndicate of English capitalists, who, it is stated, will build the line. About 11 miles of the road have already been completed. The Carrabelle, Tallahassee & Georgia R. R. Co. has been chartered to assume control of the property. Work is to begin at once. The principal offices are at Tallahasse, Fla.

Projects and Surveys.

South Knoxville.—This company expects to begin work about March 1 on its line from Knoxville, Tenn., south to South Knoxville and vicinity.

Louisa & Southeastern.—Organized in Kentucky to build a railway connecting the Ohio & Big Sandy and the Norfolk & Western railways. H. E. Huntington, Cincinnati, O., President; J. H. Northup, Ashland, Ky., Vice-President; S. S. Vinson, Secretary.

Cynthiana & Western.—Organized at Cynthiana to build a railway from Georgetown via Cynthiana, to Maysville, Ky.

North Carolina.—A charter to build a railway from Gulf, N. C., to a point in Moore Co. will be asked for at the next session of the State Legislature.

NORTHWEST.—Existing Roads.

Great Northern.—This company will build a line from the Eastern Minnesota R. R. into St. Louis townsite and thence across the bridge to New Duluth and Duluth, Minn.

Winona & Southwestern.—It is announced that the Delaware, Lackawanna & Western R. R. has advanced $500,000 to this company to be used in completing its line to Mason City, Ia.

Burlington & Missouri River.—The extension to Deadwood, S. Dak., is expected to be completed this month. Surveys are now in progress for a branch from Minnekahta to Hot Springs, S. Dak. Work is to be begun at once.

Port Arthur, Duluth & Western.—T. S. Wiley, of Port Arthur, Ont., is quoted as follows:

It is the intention of the Port Arthur, Duluth & Western R. R., to build about 10 miles of road into Minnesota. At that point they have been assured by the officials of the Duluth & Iron Range R. R. that they would meet them with a road from Ely. If the Iron Range road refuses to build, the Port Arthur road will be pushed right through the richest iron country on to Duluth, and will become a competitor of the Iron Range road in from the iron fields.

St. Louis, Alton & Springfield.—Receiver's certificates to the amount of $300,000 have been issued by the receivers of this railway. About $200,000 of the amount is to be used in making improvements to the roadbed and rolling stock. New 60 lb. steel rail will be laid between Bates and Newbern, Ill.; the ties are now being distributed. Many of the bridges will be rebuilt and repaired.

Projects and Surveys.

Chicago, Wabash & Paducah.—Chartered in Illinois to build a railway from Effingham, Ill., to Paducah, Ky.,

Among the incorporators are: R. S. Marsh, Harrisburg, Ill, and Wm. N. Johnson, Johnsonville, Ill.

Wisconsin, Bee Line & Superior.—The prospectus of this company, recently issued, states that the road will be 360 miles long, and will run from Milwaukee to Superior, Wis. It is estimated that the road will cost about $8,000 per mile. About $400,000 to aid the construction of the line will be given by the towns along the route.

SOUTHWEST.—Existing Roads.

Southern Pacific.—This company will replace the present wooden depot at San Antonio, Tex., with a brick structure to cost $75,000. It will be 300 ft. × 60 ft.

Chicago, Rock Island & Pacific.—It is stated that surveys will be resumed at once on the extension of the line south through Indian Territory.

Austin & Northwestern.—A branch is to be built from Austin, Tex., to the Colorado River, 4 miles.

Projects and Surveys.

Springfield, Sedalia, Marshfield & Northern.—At a meeting of the stockholders recently held, the following officers were elected: President, L. L. Bush, Neosho, Mo., and G. A. C. Walley, Secretary, and P. E. Burlingame, Treasurer.

Ft. Gibson, Tallequah & Great Northern.—E. P. Watson, of Burtonville, Ark., writes us that surveys have been commenced on this road. The road is 85 miles long; 35 miles in Arkansas and 50 miles in Indian Territory. J. E. Crane, Siloam, Ark., President, and S. B. Robertson, Burtonville, Ark., Chief Engineer.

ROCKY MT. AND PACIFIC.—Existing Roads.

Great Northern.—The contracts have been let for constructing the Pacific extension to the Kootenai River. The Seattle *Post Intelligencer* gives the following description of the route:

After crossing the Rocky Mountains by the Marias pass the road follows the valleys of Summit Creek, the Flathead River, Ashley Creek, Wolf's Creek, Fisher River and the Kootenai River to Lake Pend d'Oreille. The road will be within 100 miles of the boundary most of the distance above described, which is about 500 miles, and traverses a very sparsely settled country, where it will have to depend mainly on the stock raising and mining industries for business. The smaller streams above described are tributaries of the Flathead and Kootenai rivers. The road will leave the Kootenai Valley at Bonner's Ferry, where the river, which has been flowing almost due west, suddenly sweeps to the northward. The road will then run southwest to Lake Pend d'Oreille. Here the section for which the contract has been let ends. The route of the road from that point westward has not yet been determined on; if determined is kept secret. Judging from the character of the country, however, it will run down the Pend d'Oreille River, as that stream, after leaving the lake, flows through a gorge, cut through the Cabinet Mountains, and would thus seem to offer the easiest grades for traversing that range. This would bring the road into Washington at a point considerably north of Spokane Falls, and, if it continued to run due westward, would take it through Stevens and Okanogan counties.

The route across the Cascade Mountains is still a matter of speculation. Chief Engineer Beckler states that there are any number of routes which might be adopted.

Steady progress is being made by the San Francisco Bridge Co. with the bridge and trestle work for the Seattle & Montana R. R. Two spans of the Skagit bridge have been placed and work is now being done on the south span. The whole bridge will be finished about Feb. 1. On the Stillaguamish bridge men are working on the foundations, but have been delayed by high water. Of the bridges across the three mouths of the Snohomish, that over Ebey slough is practically finished; the foundations are finished on the main channel, and the spans are being placed over Steamboat slough. Piles are being driven on the north end of Smith's cove, and for the bridge across Salmon Bay will be driven in about three weeks. Piling along the North Seattle water front is still prevented by injunctions at several points.

Oregon & Washington Territory.—It is stated that Mr. G. W. Hunt has sold $2,000,000 of the bonds of this company in London. The proceeds are to be used in constructing the line from Hunt's Junction to Portland, Ore.

Northern Pacific.—The Northern Pacific R. R. is building a spur 700 ft. long from the Seattle & Northern R. R. to McNaught's wharf at Anacortes, Wash., where a depot is being built at a cost of $2,500. An extension of two miles is being run to Burrows Bay, on the west side of the island.

Coos Bay, Roseburg & Eastern.—The first 10 miles of the grading on this Oregon road was completed Jan. 5. Additional forces are to be put at work at once. The rails are now on the route from Philadelphia.

Utah Central.—It is announced that John W. Young, the President of this company, has about completed negotiations whereby he will secure the capital necessary to build the proposed extension of this road into Mexico. The road is to run from the Provo River, near Park City, Utah, east and south through the Duchesne divide, through Southeastern Colorado, Central New Mexico, down into old Mexico, through the States of Sonora and Chihuahua, and eventually into the Mexican capital itself.

Projects and Surveys.

Tacoma & Northwestern.—The engineers of this road have reached Dungeness, 16 miles east of Port Angeles, Wash. A very favorable route is reported to have been secured.

Baker City.—The right of way has been secured and surveys will soon begin for a railroad from Baker City, Ore., to the Seven Devils mines. B. U. Livens, President, Ed. Hardy, Vice-President, and J. L. Land, Secretary, all of Baker City.

FOREIGN.

Mexico.—A new concession has been granted to Delfin Sanches & Co. for the construction of a railway from Matamoras Izucar to Acapulco, Mex. Work is to begin in 10 months and the road must be completed within 5 years. The same parties also have the concession for a railway to branch from the Interoceanic Ry. at a point between the stations of Ayotla and La Compania, and skirting the foot-hills of Ixtaccihuatl, to join the main line again at a point between San Martin and Puebla.

Mexican Central.—Work has been commenced on the proposed branch from Tula Station to Pachuca, a distance of 45¼ miles.

Durango & Zacates.—A franchise has been granted by the government of Durango for the construction of a railway from Durango to Zacates, 400 miles. Arthur C. Field, San Jose, Cal.

CITY TRANSIT.

Electric Railways.—New lines or extensions are reported as probable in the following places: Wilmington, Del., address the Wilmington City Ry.; Wytheville, Va., address W. L. Yost; Portsmouth, Va.; Oakland, Cal., address W. H. Martin and M. J. Keller; St. Louis, Mo., address F. W. Rauchenstein; Toledo, O., address the Toledo Electric Street Ry.; Baltimore, Md., address the North Avenue Railway Co.; River Forest, Ill., address the Cicero & Proviso Street Ry. of Chicago.

Camden, Me.—The selectmen have refused to allow the Camden & Rockport Street R. R. to use electric motive power in the village.

Lockport, N. Y.—J. Hodge, W. T. Ransom, E. M. Ashley and others, are reported to have applied for a charter for an electric railway between this place and Olcott, 12 miles distant. The new line will be operated when built in connection with the Lockport Street R. R., owned by the same parties.

New York City.—Park Commissioner Hutchins, in behalf of the Harlem Bridge, Morrisania & Fordham R. R., has presented an application for permission to operate a trolley road.

East Orange, N. J.—The Township Committee has passed a resolution granting the Essex Passenger R. R. the right to run cars by overhead trolley system.

Camden, N. J.—The Camden Horse Ry. will probably refuse to accept the electric line built for it on Market St. There has been so much trouble with the electric system that the company decided to abandon it, at least temporarily.

Morristown, Pa.—It is reported that a Philadelphia syndicate will possibly buy the Citizens' Passenger Street car line and convert it into an electric road. C. F. Molly is the representative of the company.

Pittsburg, Pa.—The Suburban Rapid Transit Street Ry. has bought land for a power station, which will be put up as soon as possible. Heretofore power has been rented from the Pittsburg, Knoxville & St. Clair Electric Ry.

Baltimore, Md.—It is reported that the Union Passenger Ry. has secured control of the Baltimore, Catonsville & Ellicott's Mills Passenger Ry., and will probably operate it as an electric line.

Savannah, Ga.—At a recent meeting of the incorporators of the Vernon Park Ry., O. T. Rodgers was elected chairman and Ed. Karow secretary. A charter was adopted and a committee, composed of O. T. Rodgers W. W. Gordon, Jr. and J. E. Dowling, was appointed to solicit subscriptions and obtain right of way. The road will probably be operated by electricity. It is reported that surveys are being made for an electric line, of which J. S. Collins is president.

St. Augustine, Fla.—Samuel D. Wharton has petitioned the City Council to be allowed to build an electric railway. The matter is still under consideration.

Spokane Falls, Wash.—An 8-mile double-track electric railway franchise has been granted to Drumheller, Anson & Hall. Rose, Abernethy, Hoover & Brook have a franchise for another double-track line.

Horse Railways.—New roads are proposed at Columbia, S. C., address the Columbia Heights Land & Improvement Co.; Wolfe City, Tex.; Orange, Tex., address the Cow Creek Tram Co.

Hartford, Conn.—The Hartford & Wethersfield Horse R. R. has applied to the Council for permission to lay new tracks on a number of streets.

Washington, D. C.—The District Commissioners have transmitted a report to Congress on the bill chartering the East & West Washington Traction Co. The report recommends a new route for the lines and requires construction to begin within 6 months of the passage of the act and to be finished within 18 months.

New Companies.—Henning Rapid Transit Co., New York City; capital stock, $140,000; incorporators, B. S. Henning, R. M. Andrene, Jr., of New York City; W. E. Bond, of New Canaan, Conn.; Grinnell Burt, of Warwick, N. Y. Plymouth, Pa., Street Ry.; capital stock, $12,000. Milwaukee, Wis., Street Ry.; capital stock, $1,000,000; incorporators, F. G. Bigelow, H. C. Payne, G. H. Noyes. Electric Transit & Power Co., San Diego, Cal.; capital stock, $1,000,000; incorporators, G. S. Havermale, J. C. Fisher, D. D. Dare. Corpus Christi Street Ry., Corpus Christi, Tex.; capital stock, $100,000. East Bench Rapid Transit Co., Salt Lake City, Utah; capital stock, $50,000; directors, D. P. Anderson, J. R. Smith, G. Crismon.

HIGHWAYS.

Tennessee.—The people of Jefferson County will petition the Legislature to pass some practical amendments to the road law, and will ask for authority to issue bond for the improvement of public roads. About $20,000 will be spent this year in the construction of pike roads. The work will be done under the supervision of a committe composed of Judge G. L. Maloney, R. H. Edington and W. T. Jones.

Kentucky.—The injunction obtained by parties opposed to road work in Kenton Co. to prevent the issue of bonds for $17,000 has been dissolved. The bonds have been taken by the Farmers' & Traders' National Bank of Louisville.

Alaska.—San Francisco capitalists have made arrangements to build a toll road from the head of the Lynn Canal to the Yukon river, which will enable miners to get supplies without tedious and costly portages. The road will be 30 miles in the United States territory and 17 miles in British possessions.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*New York, N. Y.*—A bill has been introduced into the Assembly for a bridge over the Harlem Ship Canal at King's Bridge, to cost $400,000.

Tonawanda, N. Y.—Bonds to the amount of $10,000 are to be issued by the township of Tonawanda, N. Y., to provide for the construction of an iron bridge across Ellicott Creek.

Bridgewater, Va.—The bridge to be built across Dry River is to be 200 ft. long, divided into two spans, with divided iron pier in the river.

Harrisonburg, Va.—The iron bridge to be constructed across the Shenandoah River at Island Ford, is to be 400 ft. long, 12 ft. roadway, divided into 3 spans of 133⅓ ft. each, the ends to rest on stone abutments and supported in the river by iron piers.

Knoxville, Tenn.—The King Bridge Co. has the contract for building the iron work of the new Fifth Ave. bridge. The bridge will consist of three spans 117½ ft., 103 ft. and 80 ft. long, and about 110 ft. of trestle. Contracts for the masonry have not been let, but bids will be called for in a few days.

Chicago, Ill.—Bids will be received until Jan. 24 for constructing masonry substructure of viaduct over West Taylor St. W. H Purdy, Commissioner of Public Works, Chicago.

Hancock, Mich.—A bridge across Portage Lake between Hancock and Houghton, Mich., is talked of.

Duluth, Minn.—The Wisconsin & Minnesota Bridge Co. has been organized to build a drawbridge across the St. Louis River between the town sites of St. Louis and New Duluth. The bridge is for railway purposes. N. J. Upham, Duluth, President.

WATER-WORKS.

NEW ENGLAND.

Lawrence, Mass.—The State Board of Health ascribes the many cases of typhoid fever to the drinking water, and has notified the Mayor to warn the people that all water for drinking should be boiled 15 minutes. The supply is from the Merrimac River.

Westfort, Conn.—W. J. Finch, Town Clerk, informs us that the water-works election was postponed from Jan. 10 to Jan. 17.

MIDDLE.

Albany, N. Y.—The note in last week's issue regarding surveys for a new supply from the Normanskill, in the town of Guilderland, should be corrected as follows:

No report has yet been made upon the subject by I. M. de Varona, the Engineer, to the special water commission. Preliminary surveys are now being made under the direction of the commission of streams in Guilderland, of which the Normanskill is the principal one. This source of supply has never been condemned, but it was recommended by S. C. Sweet in 1869, on an analysis made by Prof. Maynard, of the Rensselaer Polytechnic Institute of Troy.

Batavia, N. Y.—Owing to an irregularity in the call, it was necessary to postpone the election for voting $10,000 for a new pump.

Holland, N. Y.—The Holland Water-works Co. has been incorporated with a capital stock of $10,000.

Cherry Creek.—G. N. Cowan, Stamford, has secured a franchise for works here.

New York, N. Y.—The Aqueduct Commissioners have adopted the report of the Construction Committee recommending "the immediate erection of an earth and masonry dam, to be known as the New Croton Dam, at the point indicated by the Chief Engineer, A. Fteley, in his report of Oct. 8. The latter report was abstracted in our issue of Oct. 11

Sherman, N. Y.—A franchise has been granted to G. N. Cowan, Stamford.

Sinclairville, N. Y.—The town has granted a franchise to G. N. Cowan, Stamford.

Newton, N. J.—The following is from J. S. Kintner, Town Clerk:

The authorities have been negotiating with Tippett & Wood, Phillipsburg, Pa., for the construction of works by the latter which should be rented to the town, with the privilege of buying at any time. The supply would be pumped from large springs near the town, probably to a stand-pipe. Address F. M. Ward or C. S. Steele. Population, 3,500.

Elizabethville, Pa.—Gravity works were put in operation Jan. 1. H. H. Weaver is President and C. B. Stroup, Secretary. Population, 700.

Newport, Pa.—The Newport Water Co. has been incorporated, with Joseph H. Young, C. A. Rutter and C. A. Mahanoy as directors.

Philadelphia, Pa.—Bids for a 20,000,000-gall. compound pumping engine will be received until Feb. 2 by Louis Wagner, Director Department Public Works. The engine must show a duty of 110,000,000 ft. lbs. on the b sis of 1,000,000 heat units as the equivalent of 100 lbs. of coal. The duty test will be for 24 hours. The pumps will deliver into a reservoir through a 48 in. force main about 14,000 ft. long, and the static head will be 250 ft. Full particulars can be obtained from the above, or from J L. Ogden, Chief of Bureau of Water.

Reading, Pa.—S. H. Heoff, City Engineer, has reported upon a new supply from Maiden Creek.

Brunswick, Md.—The Brunswick Water Co has been organized with C. M. Wenner, President and W. L Gross, Secretary.

SOUTHERN.

Berryville, Va.—Bids for complete works will be received until Jan. 24 by G. C. Thomas, H. W. Baker, L. Schener, Water Committee of the Berryville Water Co. Alex. T. Lee, Pittsburg, Pa., is Engineer. The supply will be from springs, by gravity. There will be gathering tiles leading from springs to a gathering pool; a stone dam near the pool to impound 6 ft. of water, with three 12-in. discharge pipes, 36 ft. long, extending through it, one of which will connect with the supply main; a river crossing, 168 ft. of 12, and about 19 miles of 10 to 4-in. pipe, 25 valves, and 13 hydrants. Of the 8-in. pipe nearly four miles will be of steel. The remainder of the pipe will be of cast-iron. For further particulars address any of the above.

Pocahontas, Va.—The following is from A. P. Baker, Recorder:

The town has had plans for works made, and a company has been in the process of organizing. It seems that the scheme has been given up owing to lack of funds. Population, about 4,500.

Statesville, N. C.—Bids for works are wanted until Feb. 2. D. A. Miller is Mayor.

Sumter, S. C.—R. O. Purdy, Mayor, informs us that negotiations for works are pending with H. O. Reid, 206 Broadway, New York.

Atlanta, Ga.—It is reported that Superintendent W. G. Richards and City Engineer Clayton began on Jan. 12 a survey for a new supply from the Chattahoochee River, to be taken at Norcross, some 20 miles above the city.

Columbus, Ga.—It is reported that a new water company is being talked of by prominent business men. Works were built in 1882 by the Columbus Water Works Co.

Dawson, Ga.—W. B. Cheatham, Mayor, informs us that notice will be given to R. L. Bennett & Co. to begin the construction of works within 30 days or forfeit their franchise.

Fort Valley, Ga.—The following is from J. A. Houser, Mayor, and W. H. Harris:

On Jan. 24 the people will vote on the issuance of bonds and the building of works. It is probable that a favorable vote will be cast, and if so four persons will be elected within 30 days to serve with the mayor as commissioners. Preliminary surveys have been made. The proposed source is springs, 8,500 from and 123 ft. below the town. A stand-pipe will probably be used. Estimated cost, indefinite, but from $12,000 to $20,000.

Tennille, Ga.—J. C. Hurman informs us that the town wishes bids for sinking a well and for material for works.

Bridgeport, Ala.—Bids for 10, 8 and 6-in. cast-iron pipe are wanted by the Bridgeport water-works.

East Lake, Ala.—Address the East Lake Land Co. regarding projected works.

Greensboro, Ala.—W. W. Powers informs us that a well is being bored with the intention of putting in works as soon as a supply is secured.

Highland, Ala.—Works are projected, but authority to build has not been obtained from the legislature.

Yazoo City, Miss.—W. G. Deles informs us that a franchise has been granted to J. A. Jones, St. Louis, for water-works, electric lights and sewerage plants. Population, 5,000.

Alexandria, La.—O. P. Williams informs us that it is desired that a company should construct works here. Two companies have proposed to do so, but have done nothing further.

Memphis, Tenn.—It is reported that the Artesian Water Co. has increased its capital stock from $750,000 to $1,000,000.

Newport, Tenn.—The following is from G. M. Belton, Secretary:

The Newport Water Co. proposes to put in gravity works, taking a supply from a mountain creek six miles distant. The estimated cost is $50,000, and will be met by the sale of stock. The present population is 1,000, and it is thought that it will increase to 4,000 within a year.

Ashland, Ky.—J. M. Gardiner, President of the Ashland Water Supply Co., informs us that the works are under way and contracts all let; estimated cost, $100,000.

Harrodsburg, Ky.—C. E. Clark informs us that an engineer is on the ground, but that nothing definite has been decided.

NORTH CENTRAL.

Columbus, O.—A. H. McAlpine, Engineer, has sent the following:

It is expected that about 20 miles of mains will be laid this year. The new pumping station will probably be put in operation about March 1. It is on the side of the city opposite the old station, and 54 ft. above it. There are two 7,500,000 gall. vertical triple compound Gaskell pumps. The supply for this station is from an open well, 25 ft. in diameter and 56 ft. deep; the water in the well rises 15 ft. above the surface, and it is estimated that the well will supply 10,000,000 galls. a day.

Lima, O.—D. E. Fritz, Superintendent, informs us that nothing has been done regarding the proposed reservoir mentioned last week, the Council having tabled the recommendation.

Put-in Bay, O.—Water-works, electric lights and a street railway, it is reported, are projected by Toledo parties.

Zanesville, O.—R. M. Laup, Superintendent, has sent the following:

At a recent joint meeting of the water-works trustees, the finance and water committees of the council, it was agreed to submit to the council recommendations for the following improvements: The building of a 50×80 ft. addition to power house No. 2; a smoke stack 140 ft. high and foundations for two pumping engines; a 4,000,000-gall. pumping engine and repairs to the present pumps. The sale of $50,000 of bonds, already issued, was also recommended. All these improvements are for the higher portion of the service.

Ironwood, Mich.—Bids are wanted for a 1,000,000-gall. pump and a boiler, or boilers, 54 ins. by 16 ft.

Belleville, Ill.—M. T. Stookey, manager, has sent the following:

An 80,000,000-gall. reservoir was built last year, and another, a fourth, is under consideration. A company was organized to introduce a new supply from the Mississippi River, but there is no prospect of anything of the kind being done.

Belvidere, Ill.—The following is from G. H. Hurlburt, City Clerk:

The city has let contracts for works to G. C. Morgan, Chicago, and construction will be started early in the spring. Water will be pumped from an artesian well to a tower by two 1,000,000-gall. Dean pumps. Population, 5,000.

Elmhurst, Ill.—W. E. Hagans, Secretary, informs us that works will be put in operation April 1 by the Elmhurst Spring Water Co. Population, 1,500.

Quincy, Ill.—The water committee having in charge the proposed new city works have received plans from Macltitchie & Nichol, Chicago, providing for a river intake, two pumps with a combined compacity of 10,000,000 galls, a brick pumping station, a 20,000,000-gall. reservoir and 71 miles of mains; estimated cost, about $600,000. Extensive works now owned by L. & W. B. Bull, were built in 1873, and are described in the MANUAL OF AMERICAN WATER-WORKS for 1889-90.

NORTHWESTERN.

Schaller, Ia.—W. J. Howard informs us that contracts for the proposed works will probably be let in June; estimated cost, $5,000.

Arkansas City, Kan.—A dispatch to the Kansas City *Times* states that the County Attorney has begun a suit in the District Court, in behalf of the State, asking that the company's franchise be forfeited. There are various charges of fraud and bribery.

Ellsworth, Kan.—(G. A. R. Reunion Grounds) Bids will be received by I. F. Collins, Chairman Trustees, until Feb. 10, for furnishing material and constructing works. Plans and specifications can be had by addressing the above at Sabetha, or can be seen at the office of H. M. Hadley, 637 Kansas Ave., Topeka.

Arcadia, Neb.—Works are projected, but it seems that nothing definite has yet been done.

Madrid, Neb.—D. D. Dayton informs us that the Madrid Water & Improvement Co., not yet organized, propose to build works the coming season. Population, 400.

Oakland, Neb.—Money for works has been voted.

SOUTHWESTERN.

Lebanon, Mo.—W. H. Allen, Engineer, Clinton, informs us that these new works will probably be considerably extended this year.

Neosho, Mo.—The following is from N. A. Morford:

Works are to be built by the Bay City, Mich., Pipe Co., and are to be completed by June 1. Water will be brought by gravity from a spring 5 miles from the town. Estimated cost, $40,000; population, 2,500.

Richmond, Mo.—The citizens have voted in favor of works.

Aransas Pass, Tex.—Works are projected. It is said that a supply could be taken from the Aransas River, at a point 8 miles distant.

Gatesville, Tex.—J. W. Sanders, Secretary, informs us that the Gatesville Water Supply Co. propose to take their supply from an artesian well.

Llano, Tex.—The following is from M. L. Lynch, Engineer, Ft. Worth:

The Llano Land Improvement & Furnace Co. are developing a town across the river from the old one, and among other things propose to put in a large water-power plant in connection with which water-works and electric lights would be operated. The plan includes a granite dam across the Llano River, a canal one mile long and a reservoir 300 ft. above the town.

Trinidad, Col.—The following is from Noral W. Wall, Engineer:

The city proposes to build works, including a 71,000,000-gall. storage and a 4,000,000 gall. distributing reservoir, with a 14-in. main 8.2 miles long connecting the two, about 12 miles of 12 × 4-in. mains, and 60 hydrants. The works are estimated to cost $150,000. Plans and specifications for the large reservoir and the pipe line have been made, and contracts for the reservoir will probably be awarded before Feb. 1. The larger reservoir will be located near the bank of the Animas River, about 9 miles west of Trinidad. The reservoir will be formed by building two dams across a valley at opposite ends of the site. The lower dam will be about 750 ft. long on top; it will have an extreme height of 30 ft., a width of 15 ft. on top, inner slopes of 2, and outer of 1½ to 1. The dimensions of the upper dam are similar. Both dams will be built of adobe clay and gravel, taken from within the reservoir basin. The embankments will be built up in about 6-in. layers, each layer to be sprinkled, then packed by driving a herd of sheep or goats over it as many times as may be necessary for its thorough compacting. There will be a gate-house of masonry. The inner slopes of the dams will have a stone riprapping 10 ins. thick, of which there will be about 5,500 sq. yds. The other estimated quantities in cubic yards are: Excavation, 500; embankment, 50,000; range masonry, 110; rubble masonry, 50; concrete, 20. The inlet and outlet pipes will be furnished and laid by the city.

PACIFIC.

Dayton, Wash.—J. H. Day informs us that a vote will be taken on the issuance of $75,000 of water bonds. A. L. Adams is Engineer. Proposed supply, mountain stream by gravity, with a 600,000-gall. reservoir.

Waterville, Wash.—Water and electric lighting works are projected by a company to which the town has given 700 acres of land.

East Portland, Ore.—The Crystal Water & Power Co. has been incorporated by E. J. Jeffrey, E. W. Paget and L. F. Chemin; capital stock, $300,000, in $10 shares.

Portland, Ore.—Necessary extensions are: A 24-in. main on First st., at a cost of $88,000; high service pumps, at a cost of $25,000 to $35,000; supply for Portland Heights.

Los Gatos, Cal.—The Cold Spring Water Co. has been incorporated, and has chosen G. S. Fife, J. L. Boone, T. C. Walter and others directors; capital stock, $60,000, of which $11,500 has been subscribed. The company proposes to supply the town of Los Gatos and the county of Santa Clara.

Pocatello, Ida.—The Center Street Water Co. has been incorporated with a capital stock of $2,000.

CANADA.

Essex, Ont.—John Milne, Mayor, informs us that works are under consideration. A. E. Lovelace is Town Clerk.

Kingston, Ont.—The following bids for furnishing and laying a suction pipe for the water-works were recently opened: A. Rousseau, Montreal, $8,735 for the whole work; F. F. Miller, Montreal, $5,900 for the material only; Brown Mfg. Co., Belleville, $8,847 for the material; T. J. Craig, Kingston, Ont., $4,539 for pier work and laying pipe. The two last were joint bids, making a total of $13,386; Kingston Foundry Co., Kingston, Ont., $13,395 for the whole work; W. McNamee, Montreal, and the Peterboro Bridge Works, $16,000 for the whole work. Rousseau's bid was afterward raised to $9,235, at which figure he was given the contract.

ARTESIAN WELLS.

Wheeling, W. Va.—An artesian well will be sunk by the Mount de Chantel Academy.

Tennille, Ga.—Bids for sinking a well are wanted. Address J. C. Hurman.

Armour, Ia.—A daily flow of about 1,500,000 galls., it is reported, has been secured at a depth of 700 ft. The well may be carried deeper, but it will first be tested.

Clarkesville, Tex.—The Board of Trade wishes bids for sinking an artesian well. Address David Rainey Chairman of Committee.

IRRIGATION.

Lincoln, Kan.—The Sacramento Irrigation Co. has been incorporated with a capital stock of $20,000.

Los Angeles, Cal.—The Dehesa Land & Water Co. has been incorporated with a capital stock of $300,000.

Modesto, Cal.—The Modesto Irrigation District has let to J. B. McDougall, for $59,000, the contract for 9,000 ft. of the heaviest work on the canal. The canal has been located from the head-waters to the district line, 16 miles.

SEWERAGE AND MUNICIPAL.

Sewers.—***Newport, R. I.***—Mr. Cotton, the street commissioner, recommends an 18 in. main sewer for Gibbs St., at a cost of $10,000, and a main sewer for Coggeshall Ave., to cost $30,000.

Orange, Mass.—The sewerage system will be completed in May, at a cost of $65,000.

Rochester, N. Y.—A main sewer is to be built following the course of Deep Hollow Creek to the river.

Syracuse, N. Y.—The business men's committee recommends that legislation be obtained for straightening Onondaga Creek and incorporating it in the system of sewerage.

Wilmington, N. C.—The question of voting $100,000 in bonds for sewerage will be submitted to the people in April.

Spartanburg, S. C.—It is proposed to issue bonds for a system of sewerage.

Bessemer, Ala.—The city will issue $50,000 in bonds for sewers and street improvements.

East Lake, Ala.—The East Lake Land Co. proposes to put in a system of sewerage.

Yazoo City, Miss.—The city has made a contract with J. K. Jones, of St. Louis, Mo., for a system of sewerage, to be completed by June.

Winnetka, Ill.—An ordinance has been introduced providing for the construction of a system of sewerage at a cost of $10,000, but there is some opposition to the scheme.

Streets.—*Allegheny, Pa.*—The Mayor has received a letter from Belgium from a firm wishing to bid on paving. It is probably for stone paving, some stone paving blocks having already been sent to this country from Belgium.

Bay City, Mich.—A considerable amount of street work is projected; asphalt or cedar blocks may be adopted.

Monroe, Mich.—Cedar paving is wanted. Address F. S. Sterling & Co.

Peoria, Ill.—Asphalt paving is proposed for Adams St.

New Orleans, La.—The Amite Gravel, Paving & Improvment Co., has been organized. President, A. T. Jannin.

Galveston, Tex.—Extensive public improvements are projected. For particulars, address H. T. Wilson, City Engineer.

Gas.—*New Albany, Ind.*—The Gaslight & Coke Co. has completed its new works, and has reduced its price to $1.50 per 1,000 cu. ft.

ELECTRICAL.

Electric Light.—New plants or extensions are reported as probable in the following places: Madison, Neb.; Jasper, Tenn., address the Jasper City Land & Mining Co.; Memphis, Tenn., address A. W. Allison; Elkton, Md.; Little Rock, Ark.; Montpelier, Ind.; Antwerp, O.; Iowa Falls, Ia.; Allegan, Mich.; Haverstraw, N. Y.; Baltimore, Md., address the Schultz Gas Fixture & Art Metal Co.; East Lake, Ala.; Richmond, Va., address the Old Dominion Iron & Nail Works Co.; Yazoo City, Miss.; Beaumont, Tex., address the Beaumont Ice, Light & Refrigerator Co.

Wakefield, Mass.—At a recent town meeting a committee was appointed to prepare a report on electric street lighting. The local company has offered to supply 1,200 c. p. lights running on a moonlight schedule until midnight at $80 per light year, and 25 c. p. incandescent lamps at $18. The committee is to report in March.

Washington, D. C.—A bill has been introduced in the Senate incorporating the National Electric Car Co. of the District of Columbia. The incorporators are A. A. Pope, of Boston; W. S. Opdyke, O. D. Baldwin and H. L. Horton, of New York; D. B. Dewey, W. T. Richards and J. Johnston, Jr., of Chicago; R. F. Henry, of St. Paul; H. C. Tuesdale, of Minneapolis. The bill allows the company to build subways in any of the streets of the District, and to conduct a general electric light and power business. It is also allowed to lease conduits at a rental not exceeding 6% of the cost. The capital stock is to be $250,000.

Plaquemine, La.—The town has decided by a vote of 48 to 40 to build an electric light plant and water works.

Abilene, Tex.—The Abilene Electric Light & Power Co., has been incorporated with a capital stock of $20,000 to erect an electric light plant.

Elmhurst, Ill.—The Village Board has resolved to contract for electric lights with the Water Co., which will increase its stock and erect a plant.

Green Bay Mich.—W. O. Stone has applied for a franchise to build and operate an electric light and power station.

The Edison Shops, at Schenectady, N. Y., will be enlarged by a 3-story building 324 ft. long with a 228-ft. X ell, and several smaller structures. Work will begin upon these early in the spring. The shops now employ 3,200 men.

New Companies.—Bushnell Electric Co., Chicago, Ill.; capital stock, $75,000; incorporators, W. M. Carpenter, M. B. Austin and F. B. Uhrig. Elkhart Electric & Railway Co., capital stock, $100,000; incorporators, E. P. Willard, J. McNaughton, O. M. Lumbert. Valdosta, Ga., Electric Light Co.; M. B. Lane, president; B. W. Benley, secretary. Union Electric Co., Birmingham, Ga.; capital stock, $50,000. Schlegel Electric Co., Akron, O.; capital stock, $10,000. Oregon Water & Electric Power Co., Oregon, Ill.; headquarters at Elgin; capital stock, $100,000; incorporators, C. W. Raymond, W. A. Shepard, L. M. Rose. People's Electric Light & Power Co., Oswego, N. Y.; capital stock, $75,000; incorporators, M. B. Richardson, A. S. Page, A. H. Failing, and others.

CONTRACTING.

Excavation and Masonry.—*Austin, Tex.*—The contract for work on a short railway to the site of the new dam has been awarded by L. G. Hester, C. E., to P. Reid; 20 cts. and 65 cts. per cu. yd. for earth and rock excavation with haul not exceeding 100 yds.; $4.75 and $8 per cu. yd. for rock and brick masonry.

Stone.—*Galveston, Tex.*—The prices for stone for the jetties, the total bids for which work were given on p. 45, were as follows: J. H. Mooney and A. M. Newton, $1 to $2.50 per ton for sandstone, $3.40 to $4 per ton for granite; B. Langtry, $2.39 to $3.68, and $3.91 to $5.13; E. H. Gaynor, $2.85 to $5.20, and $4.40 to $5.25; Southern Construction Co., $2.71 to $4.77, and $4.52 to $4.77; J. F. O'Connor, J. Laing and E. K. Smoot, $2.95 to $3.35, and $7.25 to $8.

Asphalt Paving.—*Kansas City, Mo.*—Baltimore Ave. is to be paved with asphalt; there will be a 2½-in. layer of natural Trinidad asphalt paving cement composition, upon a foundation of hydraulic cement concrete 6 ins. thick. The cost is not to exceed $2.80 per sq. yd., and the contractor is to keep the pavement in repair for 5 years. E. Butts is City Engineer.

PROPOSALS OPEN.

Pipe, Etc.—*New York, N. Y.*—Cast-iron water pipes, branch pipes, special castings, stop cocks and boxes, hydrants and boxes, manhole heads, tapping cocks, etc.; also laying pipe. Department of Public Works, 31 Chambers St. Jan. 22.

Sewer.—*Denver, Col.*—Downing Ave. sewer. Board of Public Works. Feb. 3.

Filling.—*Boston, Mass.*—About 230,000 cu. yds. of gravel filling and 50,000 cu. yds. of hardpan or clay gravel filling on dam No. 5. The Water Board, City Hall. Jan. 24.

Pier Work.—*New York, N. Y.*—Removing old pier and building new pier, No. 43, at foot of Rutgers Slip, East River. Department of Docks, Pier A North River. Jan. 23.

Dredging.—*Washington, D. C.*—The James Creek canal. The District Commissioners. Jan. 24.

Galveston, Tex. Dredging, removing stumps and logs, etc., at Buffalo Bayou. Major Chas. J. Allen, U. S. Engineer Office. Feb. 2.

Buildings.—*New York, N. Y.*—North extension and boiler house of Metropolitan Museum of Art. Department of Public Parks, 49 Chambers St. Jan. 21.

Fort Myer, Va.—Barracks, drill hall, etc. G. B. Dandy, Dep. Q. M. Gen., U. S. A., Washington, D. C. Jan. 31.

Lock.—*Nashville, Tenn.*—Cofferdam, lock pit and construction of lock No. 2, Cumberland River. Lt. Col. J. W. Barlow, U. S. Engineer Office. Feb. 12

Sidewalks.—*Brooklyn, N. Y.*—Flagging. Department of City Works, Municipal Building. Jan. 21.

Water-Works.—*Ellsworth, Kan.*—On the reunion grounds. Architect, H. M. Hadley, 627 Hadley Ave., Topeka. A. R. Greene, Secretary, G. A. R. Trustees, Topeka, Kan. Feb. 10.

Bridge Substructure and Machinery.—*Chicago, Ill.*—Remodeling machinery and putting in 2 new locomotive tubular boilers for operating Rush St. bridge, Jan. 23; masonry substructure of viaduct on W. Taylor St., Jan. 24. W. H. Purdy, Commissioner of Public Works.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., have delivered 3 freight engines to the Central New England & Western; they are building 2 eight-wheel and 2 ten-wheel engines for the Los Angeles Terminal Co.; they built 953 engines during 1890. The Rhode Island Locomotive Works, of Providence, R. I., have delivered 4 ten wheel engines to the Union Pacific. The Schenectady Locomotive Works, of Schenectady, N. Y., has an order for freight engines for the New York Central & Hudson River. The Rogers Locomotive Works, of Paterson, N. J., are building 3 decapod engines for the Chicago, Burlington & Quincy. The Cincinnati, Hamilton & Dayton has put on two powerful mogul freight engines, weighing about 65 tons. The Atchison, Topeka & Santa Fé is receiving the first installments of 75 ten-wheel engines. The Grant Locomotive Co. is said to be at work on the construction of its plant at Cicero, Ill.

Cars.—The St. Charles Car Co., of St. Charles, Mo., has completed 4 baggage cars, 6 passenger cars and 2 chair cars for the Jacksonville Southeastern, and is building 17 chair cars for the Missouri, Kansas & Texas. The Ensign Car Co., of Huntington, Va., is building 1,000 cars for the Mexican International. The Pullman Car Co., of Chicago, Ill., has built 12 chair cars for the Missouri Pacific. The Mt. Vernon Car Co. has an order for 100 coke cars for the Louisville & Nashville. The Chicago, Burlington & Quincy will place orders for about 200 coal cars. The Iron Car Co., of New York, has purchased the plant of the Huntingdon Mfg. Co. at Huntingdon, Pa. Car works are projected at Bristol, Tenn.; for particulars address the Secretary of the Chamber of Commerce.

Brakes.—The Westinghouse Air Brake Co. has orders for the equipment of nearly 30,000 freight cars. The new works at Wilmerding, Pa., have a capacity of 350 sets of brakes per day and will be enlarged.

Byram & Co., Detroit, Mich., have recently shipped 8 Colliau cupola furnaces, having a daily melting capacity of 232 tons. One of these was the sixth furnace ordered by one company.

Track Fusees.—The Western Torpedo Co., of Fostoria, O., manufactures a new form of red light signal fusee. It consists of a torch fixed in a ferule, which is weighted and provided with a sharp spike; it is thrown from the train and stands on end in the ballast, burning from 5 to 15 minutes. It is said that they cannot be extinguished by rain or wind.

The Edison Co. will build a large addition to its works at Schenectady, N. Y. The main building will be 324 ft. long, and the L extension 228 ft.

The Kenwood Bridge Co., of Chicago, Ill., has contracts for the extension of the east approach of the St. Louis bridge and for the rolling mill of the Ironton Steel Co., of Duluth, Minn. Also for 10 highway bridges of 60 to 175 ft. span. President, F. W. Barker; Engineer, Paul Millis.

Drying Apparatus.—An apparatus has been invented for drying ores, malt, fruit, etc., which is said to facilitate the handling, reduce the labor, and give greater uniformity in results. The machine consists mainly of a revolving platform, with a thin metal box platform having heating appliances within. The inventor is Alfred Guillaume, Owings Building, Chicago, Ill.

Cement Testing.—E. Thiele, of New York, agent for the Dyckerhoff Portland cement, has issued a circular on the testing of Portland cement.

Railway Transfers.—The Pennsylvania R. R. has completed two large transfer buildings at Walls Station. They are frame structures, each 800 ft. long by 60 ft. wide with 10 tracks for car storage. The yards will have a capacity for over 1,000 cars, as from 800 to 1,000 cars will be handled daily.

The National Water Purifying Co. has an order from the Manufacturing Investment Co., of Madison, Me., for a filter plant of over 2,000,000 galls. capacity per day, said to be the largest paper mill pressure filtering plant in the country. The new type of "National" horizontal filters are 8 ft. diameter.

Fire Hose.—J. J. McMullan, Mayor of Greenville, Ala., writes that the city will purchase a hose reel and 500 ft. of hose.

The Haskin Wood Vulcanizing Co. is now building an extensive and new plant at 155th St. and Harlem River, to be run in connection with the old works at 19th St. and East River. The general offices have also been enlarged at 40 Wall St. Under the late change in management the officers of the company are: President, Dan P. Eells; Vice-President, Edgar Tucker; Secretary and Treasurer, James R. Dunn, and General Manager, Harry S. Stevens. This system has been successfully tested for over seven years on the Manhattan Elevated Ry., and on a number of other points. The combined capacity of the two works is stated to be 275 M. ft. B. M. per day.

New Companies.—Springfield Gas Engine Co., of Springfield, O.; capital stock, $100,000. Tubular Axle Co., of Auburndale, O.; capital stock, $125,000. Chicago Steel & Specialty Co., of Chicago, Ill.; incorporators, Harold Sturges, J. S. Ralston and F. S. Betz; capital stock, $300,000. Clearfield Quarrying Co., of Clearfield, Pa.; incorporators, J. F. Weaver, Paul F. Weaver and W. W. Belts; capital stock, $10,000. Beach Pneumatic Conveyor Co., of Chicago, Ill.; to operate pneumatic pipe lines for conveying mails, grain, etc.; incorporators, A. G. Reed, Edwin K. Smith, James W. Beach; capital stock, $500,000. J. T. Smith Patent Boiler Co., of Baltimore, Md; president, T. A. Hulme; secretary, G. W. H. Craig; capital stock, $150,000. Louis Schwartz Machinery Co., of New Orleans, La.; president, Louis Schwartz; capital stock, $250,000. Lacroix Automatic Car Wheel Co., of Chicago, Ill.; incorporators, F. H. Cooper, John A. Lacroix and Augustus Biswanger; capital stock, $1,000,000.

Metal Market Prices.—*Rails.*—New York: $28; old rails, $22.50 for iron and $18 for steel. Pittsburg: $27.50 to $28; old rails, $25 to $27 for iron, and $17 to $17.50 for steel. Chicago: $30 to $31.50; old rails, $22.50 for iron and $14 to $18.50 for steel.

Foundry Pig Iron.—New York: $16 to $17.50. Pittsburg: $15 to $17; Chicago: $14 to $15.50.

Track Materials.—New York: steel angle bars, $1.75 to $1.90; spikes, $2 to $2.10; track bolts, 2.7 to 2.8 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.95 to 2 cts. for iron, 2 to 2.1 cts. for steel; iron or steel spikes, 2.1 cts.; iron track bolts, 2.9 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 1.95 to 2.05 cts. for iron and 2.15 to 2.25 for steel; spikes 2.15 to 2.20 cts.; track bolts, 3.05 cts. with hexagon nuts.

Pipe.—Cast iron, $27 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.45 to 4.55 cts. Chicago, 4.45 cts. St. Louis, 4.37 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.05 to 2.10 cts.; tees, 2.6 to 2.75 cts.; sheared iron plates, 2.20 to 2.25 cts.; steel plates, 2.25 to 2.30 for tank, 2.55 to 2.65 cts. for shell, 2.85 to 3 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.25 cts.; tees, 2.85 cts.; universal iron mill plates, 2.25 cts.; sheared steel bridge plates, 2.45 cts.; refined bars, 1.9 to 1.95 cts.; steel plates, 2.35 cts. for tank, 2.70 cts. for shell, 2.90 cts. for flange, 4.25 to 4.50 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.35 cts.; tees, 2.9 to 3 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.8 to 2.9 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.